# Nuclear Science Abstracts

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# NUCLEAR SCIENCE ABSTRACTS

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# NUCLEAR SCIENCE ABSTRACTS

Vol. 7 No. 4, Feb. 28, 1953

TABLE OF CONTENTS


| Category | Abstract | Page |
|---|---|---|
| REPORTS REFERENCE LIST | | iii |
| BIOLOGY AND MEDICINE | 1033 | 125 |
| Radiation Effects | 1036 | |
| Radiation Hazards and Protection | 1045 | |
| Radiation Sickness | 1047 | |
| Radiotherapy | 1048 | |
| Tracer Applications | 1050 | |
| CHEMISTRY | 1053 | 128 |
| Analytical Procedures | 1063 | |
| Crystallography and Crystal Structure | 1072 | |
| Deuterium and Deuterium Compounds | 1073 | |
| Fluorine and Fluorine Compounds | 1078 | |
| Graphite | 1084 | |
| Radiation Chemistry | 1085 | |
| Radiation Effects | 1087 | |
| Rare Earths and Rare-earth Compounds | 1088 | |
| Separation Procedures | 1089 | |
| Spectroscopy | 1093 | |
| Syntheses | 1099 | |
| Tracer Applications | 1100 | |
| Uranium and Uranium Compounds | 1102 | |
| ENGINEERING | 1104 | 134 |
| Heat Transfer and Fluid Flow | 1104 | |
| Tracer Applications | 1107 | |
| MINERALOGY, METALLURGY, AND CERAMICS | 1108 | 135 |
| Ceramics and Refractories | 1108 | |
| Corrosion | 1111 | |
| Geology and Mineralogy | 1113 | |
| Metals and Metallurgy | 1119 | |
| PHYSICS | 1149 | 140 |
| Aerosols | 1154 | |
| Cosmic Radiation | 1155 | |
| Electrical Discharge | 1159 | |
| Electrons | 1163 | |
| Gases | 1164 | |
| Instruments | 1165 | |
| Isotopes | 1173 | |
| Mass Spectrography | 1174 | |
| Mathematics | 1178 | |
| Measuring Instruments and Techniques | 1181 | |
| Mesons | 1198 | |
| Meteorology | 1212 | |
| Molecular Properties | 1213 | |
| Neutrons | 1214 | |
| Nuclear Physics | 1215 | |
| Nuclear Properties | 1217 | |
| Nuclear Reactors | 1232 | |
| Nuclear Transformation | 1233 | |
| Particle Accelerators | 1248 | |
| Radiation Absorption and Scattering | 1251 | |
| Radiation Effects | 1270 | |
| Radioactivity | 1272 | |
| Rare Earths and Rare-earth Compounds | 1283 | |
| Shielding | 1284 | |
| Spectroscopy | 1285 | |
| Theoretical Physics | 1289 | |
| AUTHOR INDEX | | INDEX-1 |
| NUMERICAL INDEX OF REPORTS | | INDEX-5 |
| NEW NUCLEAR DATA | | SUPPLEMENT-1 |


## ERRATA

NSA, Vol. 6, No. 4. In abstract 1126, p. 143, and on p. 3 of Index, H. Nowatny should be H. Nowotny.

NSA, Vol. 6, No. 6B. On p. 14 of Index, H. Nowatny should be H. Nowotny.

NSA, Vol. 6, No. 8. In abstract 2298, p. 292, in report AECU-1923, p. iv, and on p. 4 of Index, author G. L. Rotarin should be G. J. Rotariu.

NSA, Vol. 6, No. 8. In abstract 2356, p. 299, in report AECU-1889, p. iii, and on p. 2 of Index, author H. H. Gomberg should be H. J. Gomberg.

NSA, Vol. 6, No. 12B. On p. 7 of Index, H. H. Gomberg should be H. J. Gomberg.

NSA, Vol. 6, No. 12B. On p. 16 of Index, G. L. Rotarin should be G. J. Rotariu.

NSA, Vol. 6, No. 15, p. 6 of Index. Report NYO-3150 in Numerical Index should be NYO-3158.

# REPORTS REFERENCE LIST

Vol. 7, No. 4

The abstract number for each report is listed at the upper right of the entry. If the number bears an asterisk, the report is title listed only and no abstract is included.

## U. S. ATOMIC ENERGY COMMISSION DECLASSIFIED REPORTS

AECD-3480 1093
Oak Ridge National Lab.
ABSORPTION SPECTRUM OF URANYL SULFATE SOLUTION, by O. Menis and R. Rowan, Jr. July 30, 1952. Decl. Dec. 23, 1952. 10p. (AECD-3480; ORNL-1351)

AECD-3481 1094
Oak Ridge National Lab.
ISOTOPE SPECTRUM SHIFT DATA ON URANIUM SPECTRUM LINES, by D. D. Smith. Oct. 6, 1952. Decl. Dec. 19, 1952. 25p. (AECD-3481; ORNL-1412)

AECD-3482 1063
Oak Ridge National Lab.
SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM, by A. D. Horton. [nd] Decl. Dec. 22, 1952. 16p. (AECD-3482; CF-52-12-62)

AECD-3484 1272
Oak Ridge National Lab.
DOSE RATES OF RADIATION FROM THORIUM AND FROM ENRICHED URANIUM, by T. E. Bortner and H. K. Richards. Issued Apr. 9, 1951. Decl. Dec. 22, 1952. 19p. (AECD-3484; ORNL-761)

## U. S. ATOMIC ENERGY COMMISSION UNCLASSIFIED REPORTS

AECU-1972(rev.) 1213
Los Alamos Scientific Lab.
KINETICS ANALYSIS OF FLOW CATALYSIS OF ORTHO TO PARA HYDROGEN, by J. D. Rogers. [nd] 11p. (AECU-1972(rev.); LADC-1272)

AECU-2279 1119
Iowa State Univ.
PROGRESS REPORT OF THE RESEARCH PROJECT IN METALLURGY ON THE STRUCTURES AND PROPERTIES OF INTERMETALLIC COMPOUNDS FOR THE PERIOD MARCH 1, 1952 TO NOVEMBER 30, 1952, by N. C. Baenziger, J. W. Nielsen, and E. J. Duwell. Dec. 1, 1952. 6p. (AECU-2279)

AECU-2327 1165
David Sarnoff Research Center
QUARTERLY REPORT NO. 9 [ON] ELECTRONIC DEVICES FOR NUCLEAR PHYSICS [FOR] JULY, 1952 - OCTOBER, 1952. Nov. 25, 1952. 21p. (AECU-2327; Quarterly Report No. 9)

AECU-2329 1089
[Los Alamos Scientific Lab.]
ENRICHMENT OF CHROMIUM ACTIVITY THROUGH THE SZILARD-CHALMERS SEPARATION, by Milton Kahn, Arthur J. Freedman, and Ernest A. Bryant. [nd] 6p. (AECU-2329)

ANL-4875 1178
Argonne National Lab.
SOLID ANGLE SUBTENDED BY A CIRCULAR APERTURE AT POINT AND SPREAD SOURCES: FORMULAE AND SOME TABLES, by Arthur H. Jaffey. Sept. 1952. 29p. (ANL-4875; UAC-638)

BMI-773 1111
Battelle Memorial Inst.
CORROSION BY MOLTEN BISMUTH, by H. A. Pray, R. S. Peoples, and W. K. Boyd. Oct. 15, 1952. 23p. (BMI-773)

BMI-788 1120
Battelle Memorial Inst.
THE EFFECT OF PURIFICATION ON WELDS IN MOLYBDENUM, by W. H. Kearns, E. Eichen, D. C. Martin, and C. B. Voldrich. Dec. 1, 1952. 26p. (BMI-788)

BMI-791 1108
Battelle Memorial Inst.
AN APPRAISAL OF THE SINTERING BEHAVIOR AND THERMAL EXPANSION OF SOME COLUMBATES, by E. A. Durbin and C. G. Harman. Dec. 15, 1952. 14p. (BMI-791)

BMI-792 1109
Battelle Memorial Inst.
PROPERTIES OF SOME COLUMBIUM OXIDE-BASIS CERAMICS, by E. A. Durbin, H. E. Wagner, and C. G. Harman. Dec. 15, 1952. 15p. (BMI-792)

BNL-1304 1181
Brookhaven National Lab.
A RADIATION MONITOR FOR MEASURING $A^{41}$ BETA RADIATION DOSAGE AT BROOKHAVEN NATIONAL LABORATORY, by Aaron P Sanders. [nd] 32p. (BNL-1304)

CF-52-8-102 1232
Oak Ridge School of Reactor Tech.
HEAT TRANSFER PROBLEMS IN A LOW COST NUCLEAR REACTOR (thesis), by William Aaron Berger. 1952. 45p. (CF-52-8-102)

HW-24049 1212
Hanford Works
STUDIES OF DIFFUSION IN THE ATMOSPHERE; PROGRESS REPORT NUMBER ONE, by B. Shorr. Mar. 18, 1952. 44p. (HW-24049)

K-973 1166
Carbide and Carbon Chemicals Co. (K-25)
VIBRATION EFFECTS ON THE TAYLOR 206R PRESSURE TRANSMITTER, PART I, by A. H. Fowler and G. H. Job. Issued Sept. 3, 1952. 18p. (K-973)

LA-1467 1036
Los Alamos Scientific Lab.
INCORPORATION OF TRITIUM INTO THE ORGANIC COMPONENTS OF VARIOUS TISSUES OF THE MOUSE, by Ernest A. Pinson. Oct. 1952. 17p. (LA-1467)

MLM-792 1167
Mound Lab.
INSTRUMENTATION AND TECHNIQUES RESEARCH QUARTERLY PROGRESS THROUGH DECEMBER 17, 1952, by J. W. Heyd. Dec. 31, 1952. 6p. (MLM-792)

MTA-3 1168
Livermore Research Lab., Calif. Research and Development Co.
FIRING TIME OF IGNITRONS, by W. Estkowski. Nov. 4, 1952. 14p. (MTA-3)

NAA-SR-198 1121
North American Aviation, Inc.
ON THE NATURE OF RADIATION DAMAGE IN METALS, by J. A. Brinkman. Issued Dec. 22, 1952. 32p. (NAA-SR-198)

NAA-SR-200 1064
North American Aviation, Inc.
COLORIMETRIC DETERMINATION OF SMALL AMOUNTS OF URANIUM WITH 8-HYDROXYQUINOLINE IN THE PRESENCE OF IRON, by L. Silverman. Dec. 18, 1952. 22p. (NAA-SR-200)

NYO-609 1090
Rensselaer Polytechnic Inst.
THE INFRARED STUDIES OF MOLECULAR REACTIONS OF OXYGEN-CONTAINING SOLVENTS AND PROTON DONORS, by Stephen E. Wiberley, Herbert M. Clark, and Lewis G. Bassett. [nd] 21p. (NYO-609)

NYO-937 1127
Columbia Univ. School of Mines
PROGRESS REPORT [ON] THE STUDY OF DIFFUSIONLESS PHASE CHANGES IN SOLID METALS AND ALLOYS FOR JUNE 1 TO AUGUST 31, 1952, by T. A. Read, M. W. Burkart, M. Wechsler, D. S. Lieberman, and C. W. Chen. [nd] 7p. (NYO-937)

NYO-3091 1150
Columbia Univ.
INTERFACIAL THERMAL AND ELECTRICAL RESISTANCE BETWEEN STATIONARY MERCURY AND STEEL, by Charles F. Bonilla and S. J. Wang. Dec. 1, 1952. 19p. (NYO-3091)

NYO-3120 1054
Horizons, Inc.
TECHNICAL PROGRESS REPORT [ON] THE PRODUCTION OF ZIRCONIUM BY FUSED SALT ELECTROLYSIS [FOR] SIXTH QUARTER, SEPTEMBER 1 TO NOVEMBER 30, 1952, by Bertram C. Raynes, F. C. Wagner, and Morris A. Steinberg. Dec. 18, 1952. 18p. (NYO-3120)

ORNL-1406 1174
Oak Ridge National Lab.
MASS SPECTROMETER STUDY OF SILICON TETRAFLUORIDE, by Robert E. Rummel, John R. Sites, and Russell Baldock. Oct. 10, 1952. 9p. (ORNL-1406)

ORNL-1413 1154
Oak Ridge National Lab., Y-12 Area
THEORY OF A DIFFUSION BATTERY, by Wendell DeMarcus and Jess W. Thomas. Oct. 16, 1952. 28p. (ORNL-1413)

ORNL-1420 1045
Oak Ridge National Lab.
HEALTH PHYSICS DIVISION QUARTERLY PROGRESS REPORT FOR PERIOD ENDING OCTOBER 30, 1952. Issued Jan. 2, 1953. 14p. (ORNL-1420)

ORNL-1436 1170
Oak Ridge National Lab.
INSTRUMENT RESEARCH AND DEVELOPMENT QUARTERLY PROGRESS REPORT FOR PERIOD ENDING OCTOBER 20, 1952. Issued Jan. 2, 1953. 10p. (ORNL-1436)

ORNL-1447 1128
Oak Ridge National Lab.
MAKING SMALL HOLES, by John R. Sites. Nov. 10, 1952. 8p. (ORNL-1447)

ORNL-1450 1273
Oak Ridge National Lab.
TABLE OF LOG FT VALUES: OCTOBER 1952, by R. W. King, N. M. Dismuke, and K. Way. Oct. 1952. 26p. (ORNL-1450)

ORO-83 1151
Oak Ridge Inst. of Nuclear Studies
QUARTERLY PROGRESS REPORT FOR JULY 1–SEPTEMBER 30, 1952. [nd] 56p. (ORO-83)

ORO-84 1039
Tennessee Univ.
QUARTERLY PROGRESS AND WORK ACCOMPLISHMENT REPORT FOR QUARTER ENDING SEPTEMBER 30, 1952. [nd] 91p. (ORO-84)

RMO-1031 1113
Division of Raw Materials, AEC
INTERIM REPORT ON THE ORE DEPOSITS OF THE GRANTS DISTRICT, NEW MEXICO, by Irving Rapaport. Issued Nov. 1952. 19p. (RMO-1031)

UCLA-235 1034
Atomic Energy Project, Univ. of Calif., Los Angeles
CARDIO-VASCULAR AND RESPIRATORY EFFECTS OF TOLUIDINE BLUE AND RELATED ANTIHEPARIN DYES, by Thomas J. Haley and James L. Leitch. Nov. 7, 1952. 18p. (UCLA-235)

UCRL-1868 1233
Radiation Lab., Univ. of Calif., Berkeley
THE PRODUCTION OF HIGH ENERGY DEUTERONS BY THE STRIPPING OF $He^3$; PHOTOPRODUCTION OF NEUTRAL MESONS FROM DEUTERIUM (thesis), by Warren Heckrotte. Apr. 14, 1952. 81p. (UCRL-1868)

UCRL-1989 1091
Radiation Lab., Univ. of Calif., Berkeley
ION-EXCHANGE COLUMN PERFORMANCE: HYDROGEN CYCLE RATES IN NON-AQUEOUS SOLVENTS, by T. Vermeulen and E. H. Huffman. Oct. 29, 1952. 34p. (UCRL-1989)

UCRL-2004 1095
Donner Lab., Univ. of Calif., Berkeley
INFRARED SPECTRA OF SOME LIPOPROTEINS AND RELATED LIPIDS, by N. K. Freeman, F. T. Lindgren, Y. O. Ng, and A. V. Nichols. Donner Lab., Univ. of Calif., Berkeley and Radiation Lab., Univ. of Calif., Berkeley. Nov. 11, 1952. 15p. (UCRL-2004)

UCRL-2007 1234
Radiation Lab., Univ. of Calif., Berkeley
SUMMARY OF THE RESEARCH PROGRESS MEETINGS OF AUGUST 21 AND 28, AND SEPTEMBER 11, 1952, by Sergey S. Shewchuck. Nov. 11, 1952. 4p. (UCRL-2007)

UR-221 1047
Atomic Energy Project, Univ. of Rochester
THE TREATMENT OF THE ACUTE RADIATION SYNDROME WITH AUREOMYCIN AND WHOLE BLOOD, by F. W. Furth, Molly P. Coulter, R. W. Miller, J. W. Howland, and S. Swisher. Nov. 8, 1952. 48p. (UR-221)

UR-227 1040
Atomic Energy Project, Univ. of Rochester
VARIATION OF X-RADIATION-INDUCED LIPEMIA IN RABBITS WITH DOSAGE, ADMINISTRATION OF INSULIN OR AMMONIUM CHLORIDE, AND THE INCIDENCE OF TETANY, by L. T. Steadman and A. J. Grimaldi. Nov. 7, 1952. 20p. (UR-227)

## OTHER UNCLASSIFIED REPORTS OF SPECIAL INTEREST TO AEC LABORATORIES

AF-TR-6596(pt.2) 1072
New York Univ.
THE TITANIUM-NICKEL PHASE DIAGRAM, by H. Margolin, E. Ence, and J. P. Nielsen. Oct. 1951. 18p. (AF-TR-6596 (pt.2))

AMRL-83 1050
Army Medical Research Lab., Fort Knox
THE ROLE OF THE LIVER IN THYROID HORMONE METABOLISM AS STUDIED BY RADIO-IODINE IN INTRASPLENIC THYROID AUTOTRANSPLANTS, by Milton W. Hamolsky, O. R. Czerwonka, A. L. Botkin, and Z. S. Gierlach. June 3, 1952. 10p. (AMRL-83)

DC-52-5-19 1112
Babcock and Wilcox Co.
EROSION AND CORROSION STUDIES OF LIQUID METAL SYSTEMS; INVESTIGATION OF CONSTANT TEMPERATURE, FORCED CIRCULATION LIQUID LITHIUM SYSTEMS; TECHNICAL REPORT III, by A. W. Dana, Jr., O. H. Baker, and M. Ferguson. Aug. 21, 1952. 73p. (DC-52-5-19; Technical Report No. 3)

NACA-TN-2863 1104
Lewis Flight Propulsion Lab., NACA
LAMINAR NATURAL-CONVECTION FLOW AND HEAT TRANSFER OF FLUIDS WITH AND WITHOUT HEAT SOURCES IN CHANNELS WITH CONSTANT WALL TEMPERATURES, by Simon Ostrach. Dec. 1952. 55p. (NACA-TN-2863)

NBS-2033 1182
Radiation Physics Lab., National Bureau of Standards
CALIBRATION OF TYPE-APPROVAL UNITS OF THE AN/PDR-32 RADIAC SETS, by F. H. Day and T. P. Loftus. Oct. 15, 1952. 14p. (NBS-2033)

NP-4045 1110
Pennsylvania State Coll. School of Mineral Industries
TECHNICAL REPORT NO. 51 ON THE APPLICATION OF THE POLARIZATION THEORY TO CERAMIC PROBLEMS, by John W. Lindenthal. May 1952. 75p. (NP-4045; Technical Report No. 51; U22551)

NP-4201 1285
Spectroscopy Lab., Illinois Inst. of Tech.
SUBSTITUTED METHANES. XIII. INFRARED SPECTRAL DATA AND ASSIGNMENTS FOR DIBROMODIFLUOROMETHANE; TECHNICAL REPORT NO. 9 ON MOLECULAR SPECTROSCOPY, MOLECULAR STRUCTURE AND THERMODYNAMICS [FOR] SEPTEMBER 15, 1951 TO SEPTEMBER 14, 1952, by Charlotte E. Decker, Forrest F. Cleveland, and Richard B. Bernstein. Nov. 18, 1952. 4p. (NP-4201; Technical Report No. 9; U25128)

NP-4202 1286
Spectroscopy Lab., Ill. Inst. of Tech.
SUBSTITUTED METHANES. XII. INFRARED SPECTRAL DATA FOR DEUTEROTRICHLOROMETHANE; TECHNICAL REPORT NO. 8 ON MOLECULAR SPECTROSCOPY, MOLECULAR STRUCTURE AND THERMODYNAMICS [FOR] SEPTEMBER 15, 1951 TO SEPTEMBER 14, 1952, by Richard B. Bernstein, Adon A. Gordus, and Forrest F. Cleveland. Nov. 18, 1952. 3p. (NP-4202; Technical Report No. 8)

NP-4207 1183
Syracuse Univ.
FIRST QUARTERLY PROGRESS REPORT [ON] NON-ELECTRONIC DOSE RATE INDICATING SYSTEMS [FOR] JUNE 15–SEPTEMBER 15, 1952, by Myron G. Berry and Henry Linschitz. [nd] 36p. (NP-4207)

NP-4210 1122
Armour Research Foundation
FINAL REPORT [ON] DEVELOPMENT OF PROTECTIVE COATING FOR TITANIUM AND TITANIUM ALLOYS [FOR] JUNE 1, 1951–AUGUST 31, 1952, by John N. Reding, William H. Colner, Morris Feinleib, Howard T. Francis, and R. A. Lubker. Sept. 16, 1952. 16p. (NP-4210; WAL-401/46-16)

NP-4234 1169
Carnegie Inst. of Tech.
A CRITICAL COMPARISON OF BASIC METHODS OF ANALYSIS OF MAGNETIC AMPLIFIERS; MAGNETIC AMPLIFIERS–TECHNICAL REPORT NO. 11, by L. A. Finzi and G. F. Pittman, Jr. Aug. 1952. 32p. (NP-4234; Technical Report No. 11)

NP-4243 1123
Utah Univ.
HIGH PRESSURE OXIDATION OF METALS. II. TANTALUM, by William McKewan and W. Martin Fassell, Jr. Sept. 25, 1952. 17p. (NP-4243; Technical Report No. 2)

NP-4245 1124
Utah Univ.
PROGRESS REPORT NUMBER II [ON] THE HIGH TEMPERATURE OXIDATION OF METALS [FOR] FEBRUARY 29 TO JUNE 1, 1952. June 1, 1952. 11p. (NP-4245; Progress Report No. 2)

NP-4246 1125
Utah Univ.
PROGRESS REPORT NUMBER III [ON] THE HIGH TEMPERATURE OXIDATION OF METALS [FOR] JUNE 1 TO SEPTEMBER 26, 1952. Sept. 26, 1952. 12p. (NP-4246; Progress Report No. 3)

NP-4262 1053
Purdue Univ.
THE HEAT OF REACTION OF DIBORANE WITH PYRIDINE; TECHNICAL REPORT TO THE OFFICE OF NAVAL RESEARCH, by Lionel Domash and Herbert C. Brown. Dec. 15, 1952. 5p. (NP-4262)

NP-4269 1033
Air Force Radiation Lab., Univ. of Chicago
BIOLOGICAL AND MEDICAL ASPECTS OF IONIZING RADIATION: VI. CARBOXYPEPTIDASE IN MAMMALIAN TISSUE, by Robert N. Feinstein and John C. Ballin. Dec. 1952. 6p. (NP-4269; Report No. 6)

NP-4272 1085
Atomic Energy Project, Univ. of Calif., Los Angeles
QUARTERLY REPORT NO. 1 [ON] DEVELOPMENT OF CHEMICAL SYSTEMS APPLICABLE TO PRODUCTION OF THE ARMY TACTICAL AND ORGANIZATIONAL DOSIMETERS, by George V. Taplin, Clayton H. Douglas, Sanford C. Sigoloff, Donald Wales, Donald Paglia, and Charles Heller. Oct. 1, 1952. 32p. (NP-4272)

NP-4277 1126
Climax Molybdenum Co., of Mich.
THIRD ANNUAL REPORT [ON] ARC-CAST MOLYBDENUM BASE ALLOYS, by M. Semchyshen and Harold E. Hostetter. 1952. 210p. (NP-4277)

NP-4278 1037
School of Aviation Medicine
THE BIOLOGICAL AND MEDICAL ASPECTS OF IONIZING RADIATION: III. THE IMMEDIATE EFFECT OF X-RADIATION ON THE ISOLATED STRIATED FROG MUSCLE, by Herbert B. Gerstner, Charles P. Powell, and Everett O. Richey. Oct. 1952. 8p. (NP-4278; Report No. 3)

NP-4279 1038
School of Aviation Medicine
THE ANTIBODY RESPONSE OF ANIMALS EXPOSED TO X-RADIATION. IV. THE LEVELS OF X-RADIATION EXPOSURE REQUIRED TO DESTROY AN IMMUNITY TO SALMONELIA TYPHIMURIUM, by John D. Fulton and Roland B. Mitchell. Dec. 1952. 10p. (NP-4279; Report No. 4)

NP-4292 1149
New York Univ.
PROGRESS REPORT 6 ON FLUORESCENCE AND CONDUCTIVITY PHENOMENA, by Hartmut Kallmann. Oct. 1952. 68p. (NP-4292; Progress Report 6)

NP-4295 1251
Sarah Mellon Scaife Radiation Lab., Univ. of Pittsburgh
THE EFFECT OF A HIGHLY SINGULAR TRIPLET TENSOR INTERACTION OF THE P-P SCATTERING BELOW 10 MEV, by Edwin A. Crosbie. Jan. 1952. 49p. (NP-4295; U20875; Report No. 1)

SB-2(rev.) 1129*
Office of Technical Services, Dept. of Commerce
BIBLIOGRAPHY OF REPORTS ON PROTECTIVE COATINGS FOR METALS. July 1950. 21p. (SB-2(rev.))

TEI-262 1114
Geological Survey
NOTES ON THE DIFFERENTIAL LEACHING OF URANIUM, RADIUM, AND LEAD FROM PITCHBLENDE IN $H_2SO_4$ SOLUTIONS, by George Phair and Harry Levine. Sept. 1952. 23p. (TEI-262)

USNRDL-367 1287
Naval Radiological Defense Lab.
MEASUREMENT OF THE SPECTRAL INTENSITY DISTRIBUTION OF A CONVERGENT HIGH-INTENSITY LIGHT BEAM WITH A MAGNESIUM OXIDE-SMOKED PLATE, by F. W. Brown, III. July 21, 1952. 16p. (USNRDL-367)

USNRDL-371 1035
Naval Radiological Defense Lab.
VASOMOTOR ACTIVITY IN THE ISOLATED PERFUSED RAT LIVER, by R. W. Brauer, G. F. Leong, and R. L. Pessotti. Oct. 22, 1952. 32p. (USNRDL-371)

NUCLEAR SCIENCE ABSTRACTS

Vol. 7 February 28, 1953 No. 4

# BIOLOGY AND MEDICINE

1033

Air Force Radiation Lab., Univ. of Chicago

BIOLOGICAL AND MEDICAL ASPECTS OF IONIZING RADIATION: VI. CARBOXYPEPTIDASE IN MAMMALIAN TISSUE, by Robert N. Feinstein and John C. Ballin. Dec. 1952. 6p. (NP-4269; Report No. 6)

The proteolytic enzyme, carboxypeptidase, which splits chloracetyltyrosine at pH 5.5 with the liberation of acid groups and free tyrosine, has been found widely distributed in mammalian tissues. It has been found to occur in two forms, one of which is activated, the other inhibited, by cysteine. The reason for previous nondetection of this enzyme has been found to be the simultaneous occurrence in most tissues of an inhibitor of the enzyme. Enzyme and inhibitor may be separated by differential centrifugation and assayed separately. The inhibitor is apparently protein in nature. (auth)

1034

Atomic Energy Project, Univ. of Calif., Los Angeles

CARDIO-VASCULAR AND RESPIRATORY EFFECTS OF TOLUIDINE BLUE AND RELATED ANTIHEPARIN DYES, by Thomas J. Haley and James L. Leitch. Nov. 7, 1952. 18p. (UCLA-235)

The pharmacological effects of Toluidine Blue, Azure A, Neutral Red and Neutral Violet on the blood pressure and respiration have been investigated in rabbits and dogs. Toluidine Blue and Azure A are vasopressors while Neutral Red and Neutral Violet are vasodepressors. The vascular locus of action of the dyes is directly on the effector cells of the smaller blood vessels and action of the dyes is not blocked by either atropine or Dibenzyline. All of the dyes stimulate respiration, increasing both the rate and depth. Toluidine Blue and Azure A produce a definite hyperthermia in normal, atropinized, and atropinized-Dibenzylinized animals. The possible untoward reactions which might occur in humans after administration of the dyes is discussed. (auth)

1035

Naval Radiological Defense Lab.

VASOMOTOR ACTIVITY IN THE ISOLATED PERFUSED RAT LIVER, by R. W. Brauer, G. F. Leong, and R. L. Pessotti. Oct. 22, 1952. 32p. (USNRDL-371)

Transfer of the liver of the rat from the intact animal to a perfusion system is accompanied by a marked increase in the volume of blood or perfusate flowing through the organ per unit time. Relations between perfusate flow and perfusion pressure have shown that this increased perfusate flow is due to a marked loss of vasomotor tone in the isolated organ relative to the liver in situ. This vasodilatation has been traced to the disappearance from the perfusion media of a vasoconstrictor factor which was shown to be present in normal rat blood. Pharmacological investigations have established that this factor is different from known vasopressor agents found in normal blood. Evidence has been obtained indicating that this factor is released by a variety of extrahepatic tissues and is destroyed by the liver and possibly by the kidney. Some indications have been obtained that the response of the liver to this factor is altered under various conditions of liver injury. (auth)

*RADIATION EFFECTS*

1036

Los Alamos Scientific Lab.

INCORPORATION OF TRITIUM INTO THE ORGANIC COMPONENTS OF VARIOUS TISSUES OF THE MOUSE, by Ernest A. Pinson. Oct. 1952. 17p. (LA-1467)

Two groups of mice were given chronic and acute exposures, respectively, to tritium as HTO in body fluids. Both groups eliminated the tritium from body fluids with an initial half time of 1.6 to 2.0 days. After most of the tritium had been eliminated, the half time for elimination increased to about 12 days as the rate of growth of tritium out of the organic constituents of the body became the limiting factor in the elimination rate. Mice killed when the half time for elimination had lengthened to about 12 days showed a specific activity of tritium in the organic components of tissues which was many times the specific activity of tritium in body water. However, the radiation dose to the mice from the tritium incorporated in the organic constituents was small in comparison with the radiation dose from tritium in body water at levels necessary to induce the activity into the organic components either on chronic or acute exposure. It was concluded that the over-all radiation hazard due to incorporation of tritium into the organic constituents of mice is minor compared to the radiation hazard from tritium in body water. The same is probably true for man. (auth)

1037

School of Aviation Medicine

THE BIOLOGICAL AND MEDICAL ASPECTS OF IONIZING RADIATION: III. THE IMMEDIATE EFFECT OF X-RADIATION ON THE ISOLATED STRIATED FROG MUSCLE, by Herbert B. Gerstner, Charles P. Powell, and Everett O. Richey. Oct. 1952. 8p. (NP-4278; Report No. 3)

According to the effect upon the isolated muscle, three dose ranges of x radiation can be distinguished: a low dose range (0 to 30 kr) in which no significant immediate alteration from normal is found, a medium dose range (30 to 150 kr) in which muscle function is immediately compromised and gross morphological changes in coloration, translucency, and length occur, and a high dose range (above 150 kr) in which an immediate, complete abolishment of muscle function is evidenced and associated with morphological changes similar to, but much more pronounced than, those of the medium dose range. (auth)

1038

School of Aviation Medicine

THE ANTIBODY RESPONSE OF ANIMALS EXPOSED TO X-RADIATION. IV. THE LEVELS OF X-RADIATION EXPOSURE REQUIRED TO DESTROY AN IMMUNITY TO SALMONELIA TYPHIMURIUM, by John D. Fulton and Roland B. Mitchell. Dec. 1952. 10p. (NP-4279; Report No. 4)

A study was made to determine what level of whole-body x radiation would destroy an immunity to S.

typhimurium. To accomplish this study, mice were immunized with heat-killed S. typhimurium antigen and six days after immunization the animals were exposed to various levels of whole-body 260 kvp, 18 ma x radiation. Twenty-four hours after exposure to x radiation the experimental animals were infected with live S. typhimurium organisms. Under the conditions of the experiment it was observed that whole-body x radiation of 200 r or above completely destroyed the animals' resistance to S. typhimurium and, in effect, converted immune animals into nonimmune animals. The levels of x radiation required to completely destroy the animals' resistance to S. typhimurium is dependent upon the degree of immunity conferred by the immunizing procedure. (auth)

1039

Tennessee Univ.

QUARTERLY PROGRESS AND WORK ACCOMPLISHMENT REPORT FOR QUARTER ENDING SEPTEMBER 30, 1952. [nd] 91p. (ORO-84)

Progress is reported in a study of fission-product metabolism in animals. A simple procedure is described for measurement of the blood volume of farm animals. The blood volume values are reported for 20 sheep, 28 swine, 18 cattle, and 50 burros of various ages and weights. Design is reported of a metabolism cage for dogs which effects the satisfactory quantitative separate collection of urine and feces eliminated by either sex. Preliminary radioautographic demonstration of the selective uptake of $P^{32}$ by the Golgi zone of selected epithelial cells of rat intestinal mucosa is discussed. Results of a study of the effect of environmental heat and cold stress on the uptake and turnover of injected $P^{32}$ in bone, adrenals, liver, brown fat, and body fat of rats are presented in tabular form. Progress is reported in studies of radiation effects on reproductive functions in farm animals. Radiocalcium was used to study Ca metabolism in dairy cows at parturition, and at various stages of lactation. Data are presented on the distribution of $Ca^{45}$ in the blood, milk, feces, and urine at various times following oral and intravenous doses. The blood-milk pattern is given for a cow fed $Ca^{45}$ daily for several months of a lactation period. Evidence is presented that Ca ions are readily interchangeable between the various Ca fractions of blood. A simple method for quantitative estimation of these fractions is presented and data are discussed in terms of precursor-product relationships. Work was continued on the analysis of leachings from soils treated with $Ca^{45}$-labeled calcium carbonate. Problems encountered in training burros for treadmill work for a study of the effects of radiation on physical fitness are discussed. Basic experimental information accumulated from normal burros and preliminary results in the physical fitness study of the irradiated burro are included. Blood chemistry values for burros receiving a chronic exposure, until death, of 400 r of $\gamma$ radiation per day from a $Co^{60}$ source are compared with normal values. A progressive thrombocytopenia, delayed clot retraction, and prolonged whole-blood clotting time were noted in the blood of dogs following exposure to total-body radiation. Data are summarized from studies of the sexual cycle of female burros one year after irradiation, examination of the eyes of burros one year after total-body irradiation, and the examination of the eyes of swine surviving exposure to lethal doses of radiation. (C.R.)

1040

Atomic Energy Project, Univ. of Rochester

VARIATION OF X-RADIATION-INDUCED LIPEMIA IN RABBITS WITH DOSAGE, ADMINISTRATION OF INSULIN OR AMMONIUM CHLORIDE, AND THE INCIDENCE OF TETANY, by L. T. Steadman and A. J. Grimaldi. Nov. 7, 1952. 20p. (UR-227)

When rabbits are subjected to whole-body x irradiation, the average increase in plasma total lipids reaches a maximum for doses between 1000 and 1500 r. Insulin or ammonium chloride reduces the lipemia for 1000 but not for 2000 r. Insulin has little effect on the mortality but ammonium chloride increases it. Lipemia is not directly related to the degree of acidosis in individual animals. The incidence of deaths due to low calcium tetany is about 19 per cent at 1000 r and about 50 per cent at 2000 r. The average lipids in rabbits with tetany is higher than in animals not so affected. (auth)

1041

FREQUENCY OF DICENTRIC BRIDGES IN MEIOSIS IN THE GRASSHOPPER GESONIA PUNCTIFRONS, PRODUCED BY DIFFERENT DOSAGES OF X-RAYS. S. P. Ray-Chaudhuri and Ira Sarkar. Science 116, 479-82(1952) Oct. 31.

Quantitative data on the frequency of dicentric bridges with fragments in irradiated meiotic chromosomes of grasshoppers were obtained by direct cytological examination. The dicentric bridges were detected at the first anaphase of meiosis by irradiating the testes of the grasshopper Gesonia punctifrons, a species with 23 acroncentric chromosomes in the males. (L.T.W.)

1042

IMPAIRMENT OF ANTIMICROBIAL DEFENSES FOLLOWING TOTAL BODY IRRADIATION OF MICE. H. S. Kaplan, R. S. Speck, and E. Jawetz. J. Lab. Clin. Med. 40, 682-91 (1952) Nov.

A standard subacute streptococcal infection spread more rapidly in $C_{57}$ black mice subjected to single total-body x-ray exposures in the $LD_{50}$ range than in nonirradiated controls. Cumulative mortality curves in the two groups were parallel but the average survival time was significantly reduced by irradiation. Using the average day of death as a criterion, impairment of resistance was apparent within twenty-four hours after irradiation at this dose level, increased to a maximum between three and seven days after irradiation, and gradually returned to normal by fifteen days after treatment. Penicillin in large doses started within twenty-four hours after infection was effective in eliminating deaths due to bacteremia in the irradiated mice, despite the presence of a profound leukopenia. Aureomycin was somewhat less effective at the dose levels studied. In a preliminary experiment, spleen shielding failed to protect $C_{57}$ black mice against the profound impairment of antimicrobial defenses caused by systemic irradiation. It has since been shown that this response may be genetically conditioned, in that spleen-shielding of mice of this strain confers relatively little protection against the lethal effect of radiation in contrast to the striking protection noted in other strains. (auth)

1043

ATOMIC ENERGY AND THE PLANT SCIENCES. N. Edward Tolbert and Paul B. Pearson. Advances in Agron. 4, 279-303(1952)

The Atomic Energy Commission research program in plant sciences is reviewed. In addition to work in the plant sciences at its national laboratories, the AEC has forty-one cost-sharing contracts for plant-science research at twenty-nine universities, colleges, and research institutions. Apart from such direct support, the AEC produces isotopes at incentive prices and sponsors courses in the use of isotopes in research. The atomic energy program, involving plants and soils, includes studies of the effects of both internal radiation (absorbed radioisotopes and fission products) and external radiation upon the development, growth, yield, and biochemical changes in plants. In addition fundamental, cytological, and plant genetic studies applicable to plant science and the possibility of plant breeding are supported. Knowledge gained to date on the effects of radia-

tion on plants is reviewed. Applications of radioisotopes in plant metabolism studies and in studies of soils, fertilizers, and mineral nutrition are discussed. Research projects in the field of plant sciences totally or partially supported by the AEC are listed in tabular form. (C.R.)

1044

THE EFFECT OF LOCAL X-RAY IRRADIATION UPON THE TEETH AND SURROUNDING TISSUES IN YOUNG AXOLOTLS. V. V. Brunst, E. A. Sheremetieva-Brunst, and Frank H. J. Figge. J. Dental Research 31, 609-19(1952) Oct.

The teeth in the lower jaws of young axolotls (age 20 and 60 days after hatching) were irradiated with 2000 to 4000 r. On the day of treatment, some teeth were present. Animals which were irradiated 60 days after hatching had well-developed teeth. The enamel epithelium disappeared in the treated teeth, and mitotic activity was completely suppressed in the surrounding tissue. Thirty-four days after irradiation of 20-day-old axolotls with 4000 r and 43 days after irradiation of 60-day-old axolotls with 3000 r, only small remnants of teeth were observed. About 15 days later, all remnants of the teeth had disappeared. The formation of new teeth was never observed following the disappearance of the irradiated teeth, even one year after irradiation. The mechanisms of tooth formation and tooth maintenance are permanently destroyed by 2000- to 4000-r doses of x irradiation. (auth)

*RADIATION HAZARDS AND PROTECTION*

1045

Oak Ridge National Lab.

HEALTH PHYSICS DIVISION QUARTERLY PROGRESS REPORT FOR PERIOD ENDING OCTOBER 30, 1952. Issued Jan. 2, 1953. 14p. (ORNL-1420)

Data are tabulated on effectiveness of commercial mixed-resin water-purification devices and of shale, the latter in connection with ground-water surveys of waste-storage pits. Brief summaries are included of progress on calculations of neutron tolerances, stopping power of fission fragments in gases, and energy distribution of multiply scattered electrons in foils and on experimental studies of direct counting of $\alpha$ activity on particle filters, measurement of neutron and $\gamma$ radiation by high-frequency variation, x-ray dosimetry, film monitoring of fast neutrons, ionization of gases by $\alpha$ particles, and electron-attachment coefficients for various gases. Development of a recording scintillation detector to be mounted on an automobile for U prospecting is mentioned. (G.Y.)

1046

THE EFFECT OF FAT LEVEL OF THE DIET ON GENERAL NUTRITION. IX. THE RELATIONSHIP OF RADIATION INJURY IN THE RAT TO THE FAT CONTENT OF THE DIET. Amber L. S. Cheng, George D. Kryder, Lois Bergquist, and Harry J. Deuel, Jr. J. Nutrition 48, 161-82(1952) Oct.

No differences were noted in the susceptibility of rats to x-irradiation injury as related to the fat content of the diet when the animals (on the diets for three to 4 weeks) were subjected to 650 or 850 r in a single dose. On the other hand, when rats (on the diets for 12 weeks) were treated with a series of sublethal doses of x irradiation at weekly intervals (2400 r over 10 or 14 weeks in 300 r-doses), the rats receiving fat in their diets were found to be more resistant, and survived over a longer interval than did those on the fat-free regimen. The protective effect of fat was approximately as satisfactory when cottonseed oil was incorporated in the diet at a 2% level as when it comprised 15 or 30% of the diet. The beneficial action of fat is therefore believed to be related to its content of essential fatty acids. In one series of tests on young rats (two to three months old), the protective effect of fat was evident only in the male rats and not in the female rats. However, in a test with older rats (18 months), both sexes were protected to an equal extent by the incorporation of fat in the diet. In spite of the beneficial results produced by fat in lowering the mortality rate of rats following exposure to x irradiation, no concomitant improvements were noted in such indices of x-irradiation injury as hemoglobin level or leukocyte count. 52 references. (auth)

*RADIATION SICKNESS*

1047

Atomic Energy Project, Univ. of Rochester

THE TREATMENT OF THE ACUTE RADIATION SYNDROME WITH AUREOMYCIN AND WHOLE BLOOD, by F. W. Furth, Molly P. Coulter, R. W. Miller, J. W. Howland, and S. Swisher. Nov. 8, 1952. 48p. (UR-221)

The use of aureomycin and of whole-blood transfusion singly and in combination for the treatment of the acute radiation syndrome in dogs was investigated. Statistical analysis of the data indicates that some therapeutic benefit may be derived from the administration of antibiotics and whole blood in the acute radiation syndrome under certain conditions. The autopsy examinations done on dogs which died during the experiment indicated that a hemorrhagic diathesis was the principal cause of death, and that this bleeding was not affected by the therapy used. The pathologic data suggest that a higher incidence of pulmonary hemorrhage and edema occurred in the blood-treated dogs, indicating a potential hazard in the administration of whole blood during certain phases of the acute radiation syndrome. The possible reasons for the failure of the therapy and a discussion of the statistical treatment of the data are included. (C.R.)

*RADIOTHERAPY*

1048

NEW METHODS IN THE RADIATION THERAPY OF SKIN DISEASES, WITH PARTICULAR CONSIDERATION OF THE DERMOPAN APPARATUS (10 TO 50 KV). I. DERMOPAN CHARACTERISTICS. E. Heinz Graul. Z. Haut- u. Geschlechtskrankh. 8, 201-6(1952). (In German)

The Dermopan x-ray-therapy apparatus, which has 10, 29, 43, and 50 kv standard voltage steps, can deliver intense radiation doses (~200,000 r/min at 50 kv and 5 cm focus-skin distance). For practical dermatology, accurate adjustment to doses below 100 r/min is possible with Al filters. Curves of dose vs. filter thickness, ratio of deep to surface dose, and dose distribution are plotted and compared with those of similar apparatus. (G.Y.)

1049

THE PATHOLOGIC EFFECTS OF $I^{131}$ ON THE NORMAL THYROID GLAND OF MAN. A. Stone Freedberg, George S. Kurland, and Herrman L. Blumgart. J. Clin. Endocrinol. and Metab. 12, 1315-48(1952) Oct.

The pathologic findings are described in 16 euthyroid patients who expired from seven to one thousand and sixty-nine days after the oral administration of from 17 to 157 millicuries of $I^{131}$. Radioactive iodine was utilized in 15 of the 16 patients because of intractable angina pectoris or congestive heart failure; the remaining patient had a primary carcinoma of the thyroid. (auth)

*TRACER APPLICATIONS*

1050

Army Medical Research Lab., Fort Knox

THE ROLE OF THE LIVER IN THYROID HORMONE METABOLISM AS STUDIED BY RADIO-IODINE IN INTRA-

SPLENIC THYROID AUTOTRANSPLANTS, by Milton W. Hamolsky, O. R. Czerwonka, A. L. Botkin, and Z. S. Gierlach. June 3, 1952. 10p. (AMRL-83)

The role of the liver in the metabolism of endogeneous thyroid hormone, labeled by $I^{131}$, in intra-splenic thyroid autotransplants has been studied. The method permits serial observations on the functional "take" of the transplants, as well as the determination of uptake and conversion of iodide and the level of labeled protein-bound I. The data suggest a partial removal or inactivation of thyroid hormone by the liver under these experimental conditions. (auth)

1051

RADIOACTIVE THYROTROPIC HORMONE PREPARATIONS. Martin Sonenberg, Albert S. Keston, William L. Money, and Rulon W. Rawson. J. Clin. Endocrinol. and Metab. 12, 1269-86(1952) Oct.

A pituitary preparation with thyrotropic and gonadotropic activity has been coupled with $S^{35}$-labeled diazobenzene sulfonic acid. The biologic activity of labeled pituitary hormone preparations with reference to thyrotropin has been found to decrease with an increasing number of substituent groups on the protein. In the localization studies, significant concentrations of radioactivity have been found in the thyroid, gonads, and liver after administering labeled thyroid-stimulating hormone preparations to the male chick. (auth)

1052

APPLICATION OF RADIOACTIVE AND STABLE ISOTOPES IN PHARMACOLOGICAL RESEARCH. Max Frimmer. Angew. Chem. 64, 638-42(1952) Dec. 7. (In German)

The principal applications of tracers in pharmacy are reviewed. Problems in physiological effects of adrenalin, barbituates, antihistamines, dicumarol, mescaline, antibiotics, alkaloids, vitamins, hormones, etc. to which tracers have been applied are discussed briefly. 75 references. (G.Y.)

## CHEMISTRY

1053

Purdue Univ.

THE HEAT OF REACTION OF DIBORANE WITH PYRIDINE; TECHNICAL REPORT TO THE OFFICE OF NAVAL RESEARCH, by Lionel Domash and Herbert C. Brown. Dec. 15, 1952. 5p. (NP-4262)

The heat of reaction of diborane with a number of pyridine bases has been determined. A plot of the heat of reaction of diborane with the alkylpyridines, vs. the energy of activation for the reaction of methyl iodide with the same pyridines, yields a straight line. The melting points and vapor pressures of the addition compounds of diborane with a number of alkylpyridines have been determined. (auth)

1054

Horizons, Inc.

TECHNICAL PROGRESS REPORT [ON] THE PRODUCTION OF ZIRCONIUM BY FUSED SALT ELECTROLYSIS [FOR] SIXTH QUARTER, SEPTEMBER 1 TO NOVEMBER 30, 1952, by Bertram C. Raynes, F. C. Wagner, and Morris A. Steinberg. Dec. 18, 1952. 18p. (NYO-3120)

The production of Zr metal by the electrolysis of fused salt baths with potassium Zr fluoride is reported in detail. An electrolytic cell capable of producing 4 pounds of Zr metal during one eight-hour day is described. The results of twenty-nine runs in this cell are tabulated and evaluated. It has been established that the production of Zr by this electrolytic process is completely feasible on an enlarged scale and, therefore, would be feasible for large pilot-plant operation. Included in this report are analytical evaluations of the Zr produced, the hardness of the metal produced, and typical screen analyses. In the section on physical metallurgical properties, the identification of a hydride phase has been confirmed in the metal. (auth)

1055

DIMETHYLBERYLLIUM. PART I. VAPOUR PRESSURE AND VAPOUR-PHASE ASSOCIATION. G. E. Coates, F. Glockling, and N. D. Huck. J. Chem. Soc., 4496-4501(1952) Nov.

The vapor pressure of dimethylberyllium has been measured between 100 and 180°, and the vapor density, between 160 and 200°. The extrapolated sublimation temperature is 217°. From a study of the pressure dependence of the vapor density it is concluded that the vapor contains monomer, dimer, trimer, for which structures are proposed, and higher polymers, the last only becoming important under near-saturation conditions. Heat and entropy terms have been obtained for the monomer-dimer and the monomer-trimer equilibria. The significance of the apparent heat of sublimation is discussed in the light of the association equilibria, and the heat of sublimation of the solid polymer into monomer is deduced. The energy difference between two half bonds and one whole bond is 9 to 12 kcal, depending on the degree of polymerization; this is compared with the value of 10 kcal for the similar quantity in trimethylaluminum and its dimer. The entropy change on dimerization is discussed in relation to the use of 3d orbitals by carbon in compounds of this type. (auth)

1056

DIMETHYLBERYLLIUM. PART II. CO-ORDINATION COMPOUNDS. G. E. Coates and N. D. Huck. J. Chem. Soc., 4501-11(1952) Nov.

Dimethylberyllium forms coordination compounds with trimethylamine, trimethylphosphine, and dimethyl and diethyl ether, but not with trimethylarsine or dimethyl sulfide. The properties of these indicate that the order of stability of the compounds is N > P > O. Whereas the coordination affinity of trimethylamine to dimethylberyllium is more than sufficient to break down the polymeric structure of the latter, forming the volatile substance $Me_2Be{-}\overset{+}{N}Me_3$, there is evidence to show that weaker donor molecules such as trimethylphosphine have a coordination affinity similar in magnitude to the affinity of dimethylberyllium molecules for each other; the latter situation results in the formation of a number of coordination compounds with various Be:P ratios, and in some rather peculiar properties shown by dimethylberyllium–trimethylphosphine and –dimethyl ether systems. The formation of an unstable compound $(Me_2Be)_1$-$(NMe_3)_3$ has been demonstrated; this is interpreted on the basis of half-bonding between one N and two Be atoms. (auth)

1057

DIMETHYLBERYLLIUM. PART III. REACTIONS WITH SOME COMPOUNDS CONTAINING REACTIVE HYDROGEN. G. E. Coates, F. Glockling, and N. D. Huck. J. Chem. Soc., 4512-5(1952) Nov.

Dimethylberyllium reacts with methylamine, dimethylamine, dimethylphosphine, methyl alcohol, methanethiol, or HCl, forming methane and di-, tri-, or polymeric products. Dimethylamine affords a trimeric compound $(MeBe{\cdot}NMe_2)_3$, to which a cyclic structure has been assigned. Methyl alcohol gives a dimeric methoxide $(MeBe{\cdot}OMe)_2$, which readily disproportionates to dimethylberyllium and beryllium dimethoxide. The other substances studied lead to involatile or but slightly volatile products of doubtless polymeric constitution. (auth)

1058

THE POTASSIUM THORIUM FLUORIDES. W. J. Asker, E. R. Segnit, and A. W. Wylie. J. Chem. Soc., 4470-9(1952) Nov.

Thermal analysis and microscopic examination have shown the following compounds to exist in the system KF–$ThF_4$: $\alpha$-$K_5ThF_9$, $\beta$-$K_5ThF_9$, $K_3ThF_7$, $\alpha$-$K_2ThF_6$, $\beta$-$K_2ThF_6$, $KThF_5$, $KTh_2F_9$, and $KTh_3F_{13}$. The compound $\alpha$-$K_5ThF_9$ has not previously been described. The compound $K_3ThF_7$ is stable only at high temperatures and has been shown to disproportionate at lower temperatures into a mixture of $\beta$-$K_2ThF_6$ and $\beta$-$K_5ThF_9$. Discordant views in the literature as to the formula of the compound of highest Th fluoride content have been discussed, and the formula $KTh_3F_{13}$ for this compound confirmed. Partial solid solution has been shown to occur between $KTh_3F_{13}$ and $ThF_4$. Optical properties have been recorded for the majority of the compounds listed. Systematic precipitation studies in the systems KF–$Th(NO_3)_4$–$H_2O$ and $KNO_3$–$Th(NO_3)_4$–HF–$H_2O$ have shown that cationic complexes of Th and F strongly influence the composition of the precipitated KTh fluorides. The hydrated compounds $\alpha$-$K_2ThF_6 \cdot nH_2O$, $KTh_2F_9 \cdot nH_2O$, and $ThF_4 \cdot nH_2O$ have been isolated from solution, but the compound $KThF_5 \cdot nH_2O$ could not be isolated in a substantially pure state. Lattice water in the precipitated phases can be removed at 300° without appreciable loss of F. (auth)

1059

STRUCTURAL CHEMISTRY OF THE ALKOXIDES. PART II. TERTIARY ALKOXIDES OF SILICON, TITANIUM, ZIRCONIUM, AND HAFNIUM. D. C. Bradley, R. C. Mehrotra, and W. Wardlaw. J. Chem. Soc., 4204-9(1952) Nov. (cf. NSA 6-5080)

The tertiary alkoxides $M(O{\cdot}CMe_nEt_{3-n})_4$, and $M(O{\cdot}CMe_2R)_4$, $M(O{\cdot}CMeEtPr^i)_4$, where M = Ti or Zr; n = 0, 1, 2, or 3; and R = Me, Et, $Pr^n$, $Pr^i$, or $Bu^t$, have been prepared. Ebullioscopic measurements show that these compounds are monomeric. Vapor-pressure measurements on the lower tertiary alkoxides show that boiling points and latent heats increase with molecular size but entropies of vaporization show little variation. A comparison of isomeric tertiary, alkoxides reveals the effect of chain branching on volatility. Most Ti tertiary alkoxides are less volatile than their Zr analogues while Hf tert.-amyloxide is more volatile than the Zr derivative. Hence the surprising order of volatilities, Hf > Zr > Ti, is found for the tert.-amyloxides. The position of Si in this series is discussed. (auth)

1060

THE CHEMISTRY OF PROTACTINIUM. G. L. Miles. Revs. Pure Applied Chem. 2, 163-73(1952) Sept.

A brief review of Pa chemistry is presented. 54 references. (G.Y.)

1061

EFFECT OF TITANIUM IN GALVANIC CORROSION. Henry Paige and Sara J. Ketcham. Corrosion 8, 413-6(1952) Dec.

A series of laboratory tests has been performed in which various metals have been coupled to either stainless steel or titanium in normal sodium chloride. Electrode potential studies have also been made on specimens given different surface treatments. Comparison of the data indicates that the electrochemical behavior of titanium and stainless steel is similar under the test conditions. Mechanical testing of heat treated specimens reveals that exposure to oxidizing conditions above 1000 degrees F has a deleterious effect on the ductility of titanium as well as its resistance to stress-corrosion conditions. (auth)

1062

ISOTOPIC EXCHANGE RATES AS CRITERIA OF SURFACE HETEROGENEITY. R. P. Eischens. J. Am. Chem. Soc. 74, 6167-71(1952) Dec. 20.

The exchange between gaseous CO and CO chemisorbed on iron has been studied with $C^{14}$ tracer. The most weakly bonded CO exchanges the fastest. The exchange data show that the iron is heterogeneous. Kinetic treatment of the data indicates that the heterogeneity is due to differences between a relatively few homogeneous portions rather than to a spectrum of chemisorption bond strengths. In some cases it is not possible to distinguish between the two types of heterogeneity. No C isotopic effect was found in these experiments. (G.Y.)

*ANALYTICAL PROCEDURES*

1063

Oak Ridge National Lab.

SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM, by A. D. Horton. [nd] Decl. Dec. 22, 1952. 16p. (AECD-3482; CF-52-12-62)

Development work is being continued on the use of thoron (1-(o-arsonophenylazo)-2-naphthol-3,6-disulfonic acid) as a spectrophotometric reagent. Its previous use for the determination of Th(IV), together with experimental results on its formation of complexes with Sn(IV), Ti(IV), Hf(IV), and Zr(IV), indicates that thoron may be specific for metals that have a valence of plus four in the formation of their salts. Thoron has been used successfully for the determination of Zr. The method covers a range of 10 to 100 μg of Zr with a precision of 5.7% in the 10 μg range, and 2.9% in the 100 μg range. The method is simple, rapid, and does not require a skilled analyst. The reagent, although complex, is now available commercially, and requires little preparation. There are very few interferences which cannot be reduced to non-interfering states, or removed from the sample without loss of Zr. (auth)

1064

North American Aviation, Inc.

COLORIMETRIC DETERMINATION OF SMALL AMOUNTS OF URANIUM WITH 8-HYDROXYQUINOLINE IN THE PRESENCE OF IRON, by L. Silverman. Dec. 18, 1952. 22p. (NAA-SR-200)

In aqueous uranyl solution, iron is converted to ferrocyanide, then uranyl quinolate is extracted into chloroform solution and measured, by absorption, at selected wavelengths. 0.05 mg of uranium is accurately measured in a volume of 25 ml of chloroform. The test sample may contain up to 200 mg of iron. An application of this procedure is the determination of uranium in graphite, after the sample is ashed. An advantage of this procedure over the usual gravimetric $U_3O_{7+}$ determination is that the latter is dependent upon temperature of burning. (auth)

1065

DETERMINATION OF NIOBIUM AND TANTALUM IN COLUMBITE AND EUXENITE. W. D. Treadwell, H. Guyer, Renate Hauser, and G. Bischofberger. Helv. Chim. Acta 35, 2248-59(1952) Dec. 1. (In German)

Chlorination of mixtures of Nb, Ta, U, Ti, Fe, rare-earth, and Th oxides with $CCl_4$ in HCl at 500°C is described. Fractionation of the volatile chlorides and complete separation of Ti as $TiCl_4$ was accomplished. The reducibility of $H_2SO_4$ solutions of niobic acid with the Zn reductor was investigated; a reproducible technique giving 93.5% reduction is described. Color changes of Nb(III) oxide complexes in $H_2SO_4$ during electrometric oxidation are discussed. An orientation study was made on the spectrographic analysis of $Nb_2O_5$-$Ta_2O_5$ mixtures. (G.Y.)

1066

NOTE ON THE POLAROGRAPHIC DETERMINATION OF ZIRCONIUM. R. P. Graham, E. VanDalen, and A. M. C. Upton. Can. J. Chem. 30, 1069-72(1952) Dec.

A useful polarographic method for the determination of Zr can be based on the findings that m-nitrobenzoic acid is polarographically reducible and that this compound is a highly selective precipitant for Zr. In principle, the method

consists of precipitating Zr with m-nitrobenzoic acid, dissolving the filtered and washed precipitate in hydrochloric acid, and measuring the height of the polarographic wave corresponding to the reduction of the m-nitrobenzoic acid (to the hydroxylamine stage) in a suitable supporting electrolyte. The method is accordingly an indirect one for Zr, and depends on the specificity of m-nitrobenzoic acid as a precipitant. The method has been applied successfully to the determination of Zr in Mg-base alloys. (auth)

1067

ANALYTICAL CHEMISTRY OF NIOBIUM AND TANTALUM; ATMOSPHERIC CHLORINATION OF HYDROLYZED OXIDE PRECIPITATES. C. F. Hiskey, Leonard Newman, and R. H. Atkinson. Anal. Chem. 24, 1988-91(1952) Dec.

The method previously described (NSA 6-2608) for atmospheric chlorination of oxides associated with Nb and Ta in their minerals was developed for synthetic oxide mixtures prepared from pure, freshly ignited oxides. It has been found that the procedure frequently fails for oxide mixtures prepared from aqueous solutions. Factors affecting the chlorination have been found to be amorphousness, severity of ignition, acidity of the associated oxide, proportion of oxides of different acidities, and surface conditions. The minerals likely to chlorinate readily and with difficulty are listed. (G.Y.)

1068

DETERMINATION OF SMALL AMOUNTS OF CHLORIDES IN TITANIUM SPONGE. Maurice Codell and James J. Mikula. Anal. Chem. 24, 1972-3(1952) Dec.

In Ti casting operations, even low concentrations of chloride cause spattering of molten metal and interfere with the production of satisfactory castings. It is therefore necessary to have a procedure by which the chloride content of Ti sponge can be accurately determined. An accurate and fairly rapid method has been developed which is satisfactory for chloride concentrations in the range 0.001 to 0.20%. The production of Ti sponge is increasing rapidly and meth ods for quality control must be capable of handling large numbers of samples simultaneously. This procedure is well adapted for use in routine analysis and can be carried out with apparatus common to most laboratories. (auth)

1069

FLUORIMETRIC DETERMINATION OF TRACE AMOUNTS OF BERYLLIUM. George Welford, and John Harley. Am. Ind. Hyg. Assoc. Quart. 13, 232-4(1952) Dec.

An investigation of the sensitivity of Morin as a reagent for the detection and determination of Be is reported. A procedure for the separation and subsequent fluorimetric analysis is outlined. Results indicated that the fluorimeter allowed the detection of 0.005 μg of Be per sample. (J.E.D.)

1070

PAPER CHROMATOGRAPHY OF INORGANIC IONS. PART IV. M. Lederer. Anal. Chim. Acta. 7, 458-61(1952) Nov.

Filter paper impregnated with salts has been used for paper chromatography of inorganic cations. The $R_F$ values of a number of cations, among them $Ti^{+4}$, $V^{+5}$, and $UO_2^{++}$, on such paper differ considerably from those on untreated paper, and in some cases better separations are possible. The $R_F$ value of cations varies with the cation of the salt used for impregnation in the same manner as has been observed for "salting out" in solvent-solvent extraction. (auth)

1071

ON THE MICROSCOPIC DISTINCTION OF ZIRCONIUM AND HAFNIUM. C. J. van Nieuwenburg and J. W. L. van Ligten. Anal. Chim. Acta. 7, 390-2(1952) Nov.

A method has been worked out for the microscopic distinction of Zr and Hf by means of Martini's reagent: quinoline and ammonium thiocyanate. When using this reaction exactly as described by Martini, there generally is a difference in the shape of the primarily formed crystals. When using 25% formic acid as a solvent instead of 1:2 HCl, Hf always gives a good reaction, wheras the Zr reaction is prevented. (auth)

*CRYSTALLOGRAPHY AND CRYSTAL STRUCTURE*

1072

New York Univ.

THE TITANIUM-NICKEL PHASE DIAGRAM, by H. Margolin, E. Ence, and J. P. Nielsen. Oct. 1951. 18p. (AF-TR-6596 (pt.2))

The complete diagram from 0 to 100% nickel and a comparison of the phase diagrams for Process A sponge and iodide titanium-base nickel alloys up to 15% nickel are presented. Comparisons of results have been made with other work described in the literature. Copper contamination encountered in high-nickel alloys was almost entirely eliminated by using smaller charges and shorter melting times. Summaries of procedures for alloy preparation, melting, heat treatment, metallographic and x-ray investigation are included. (auth)

*DEUTERIUM AND DEUTERIUM COMPOUNDS*

1073

INFRA-RED SPECTRUM OF NITRIC AND OF DEUTERONITRIC ACID VAPOUR. COMPLETION OF IDENTIFICATION OF THE FUNDAMENTAL FREQUENCIES. ENTROPY OF NITRIC ACID. BARRIER RESISTING ROTATION OF THE HYDROXYL GROUP. Henry Cohn, C. K. Ingold, and H. G. Poole. J. Chem. Soc., 4272-82(1952) Nov.

The infrared spectra from 3700 to 440 $cm^{-1}$ of nitric and deuteronitric acid as vapor are recorded and interpreted. Those fundamental frequencies that previous study of the Raman spectra of these acids had left unknown or doubtful have been found and identified, and those assignments of previously observed frequencies that had remained dubious have been settled. The derivation of thermodynamic quantities is illustrated by a calculation of the entropy of nitric acid, which agrees well with the calorimetric value. The barrier resisting rotation of the hydroxyl or deuteroxyl group about the NO bond in the gaseous molecules is computed, from the torsional frequencies and entropy, to be in the neighborhood of 10 kcal/mole. This large value is ascribed to internal hydrogen-bonding in the gas molecules. The frequency differences between vapors and liquids can be understood to result from intermolecular hydrogen-bonding in the liquid acids. (auth)

1074

OSCILLATION SPECTRA AND COEFFICIENTS OF INFLUENCE OF ETHANE AND DEUTEROETHANE MOLECULES. S. A. Antipina and P. G. Maslov. Zhur. Eksptl'. i Teoret. Fiz. 22, 705-15(1952) June. (In Russian)

A more accurate system of the potential-energy constants $K_{ij}$ of ethane, $C_2H_6$, and deuteroethane, $C_2D_6$, is obtained independently of the familiar system of dynamic coefficients of these molecules (Stepanov, Zhur. Fiz. Khim. 15, 865 (1941)). The first derivatives of frequencies with respect to the parameters $k_{ij}$ are obtained, and the oscillation frequencies are expanded into terms each of which depends only on a definite parameter.

1075

ABSORPTION SPECTRA OF SH AND SD PRODUCED BY FLASH PHOTOLYSIS OF $H_2S$ AND $D_2S$. D. A. Ramsay. J. Chem. Phys. 20, 1920-7(1952) Dec.

$H_2S$ and $D_2S$ were irradiated in a flash photolysis apparatus, and the absorption spectra of the products were photographed within 1 msec of the photolysis flash using the second order of a 21-ft grating spectrograph. The (0,0) and (1,0) bands of SH and SD were observed and analyzed. The follow-

ing molecular constants for SH were obtained: $^2\Sigma^+$ state: $B'_e = 8.538_1$ cm$^{-1}$, $\alpha'_e = 0.509_1$ cm$^{-1}$, $r'_e = 1.421_5$ A, $\nu_{00} = 30{,}662.4_2$ cm$^{-1}$, $\Delta G'_{1/2} = 1784.6_3$ cm$^{-1}$, $\gamma_0 = 0.313$ cm$^{-1}$. $^2\Pi$ state: $B''_0 = 9.461_1$ cm$^{-1}$, $r''_0 = 1.350_3$ A, $A = -376.9_6$ cm$^{-1}$. The rotational lines of the (1,0) SH band were observed to be diffuse, indicating a predissociation in the first vibrational level of the $^2\Sigma^+$ state. This establishes an upper limit of 9.27 kcal and a lower limit of 66.3 kcal for the ground state dissociation energy of SH. (auth)

1076

SUBSTITUTED METHANES. IX. RAMAN AND INFRARED SPECTRA, ASSIGNMENTS, POTENTIAL CONSTANTS, AND CALCULATED THERMODYNAMIC PROPERTIES FOR $CHClBr_2$ AND $CDClBr_2$. Donald A. Pontarelli, Arnold G. Meister, Forrest F. Cleveland, Fred L. Voelz, Richard B. Bernstein, and Robert H. Sherman. J. Chem. Phys. 20, 1949-54(1952) Dec.

Raman displacements, semiquantitative relative intensities, and quantitative depolarization factors for liquid chlorodibromomethane and deuterochlorodibromomethane, and infrared wave numbers and per cent transmission curves for both the liquid and gaseous states in the region 400 to 4300 cm$^{-1}$ were obtained and compared with previous data. A normal-coordinate treatment (Wilson FG matrix method) was carried out, and a consistent set of potential constants for both molecules was determined, using a potential energy function containing all possible second-degree terms. Assignments were made for all observed bands. The heat content, free energy, entropy, and heat capacity at constant pressure were calculated for 12 temperatures from 100 to 1000°K. (auth)

1077

SUBSTITUTED METHANES. XII. INFRARED SPECTRAL DATA FOR DEUTEROTRICHLOROMETHANE. Richard B. Bernstein, Adon A. Gordus, and Forrest F. Cleveland. J. Chem. Phys. 20, 1979(1952) Dec.

Observed wave numbers, intensities, and assignments of $CCl_3D$ infrared bands are listed for both liquid and gaseous states. (G.Y.)

*FLUORINE AND FLUORINE COMPOUNDS*

1078

THE REACTIONS OF METALLIC SALTS OF ACIDS WITH HALOGENS. PART III. SOME REACTIONS OF SALTS OF FLUOROHALOGENOACETATES AND OF PERFLUORO-ACIDS. R. N. Haszeldine. J. Chem. Soc., 4259-68(1952) Nov.

Reaction of Ag salts of fluorohalogeno-acids with chlorine, bromine, or iodine constitutes a general method for the synthesis of fluorohalogenohydrocarbons, and is exemplified by the preparation of the new compounds CHClIF, CHBrIF, $CClBr_2F$, $CCl_2BrF$, $CCl_2IF$, $CClBrF_2$, and $CClIF_2$. The stability of the Ag salts of incompletely halogenated fluoroacids and of fluorohalogenomethanes is considered. The Ag salt reaction applied to the perfluoroalkanecarboxylic acids yields a series of perfluoroalkyl chlorides, bromides, and iodides, $CF_3{\cdot}[CF_2]_n{\cdot}X$ (X = Cl, Br, or I; n = 1 to 6). The Na salts of the perfluoro acids decompose when heated, giving high yields of the perfluoroalk-1-enes, and a mechanism for this general reaction is advanced. Conversion of chlorotrifluoroethylene into bromotrifluoroethylene is described. (auth)

1079

FLUORO-OLEFINS. PART I. THE SYNTHESIS OF HEXAFLUOROBUTA-1:3-DIENE. R. N. Haszeldine. J. Chem. Soc., 4423-31(1952) Nov.

A general method for the synthesis of fluorohalogenobutadienes is described and illustrated by the conversion of chlorotrifluoroethylene into hexafluorobuta-1, 3-diene in 80% yield. Addition of iodine monochloride or monobromide to chlorotrifluoroethylene gives chlorofluoro- and bromochlorofluoroiodo compounds, which react readily with Hg in ultraviolet light or with Zn in dioxan, to yield hexafluoro-1, 2, 3, 4-tetrahalogenobutanes. Dehalogenation of the last compounds with Zn and ethanol affords hexafluorobutadiene. Syntheses of certain fluoro- and fluorohalogenobutenes, including octafluorobut-2-ene, are described, and infrared and ultraviolet spectra are presented and discussed. (auth)

1080

INFRARED AND RAMAN SPECTRA OF FLUORINATED ETHYLENES. V. HEXAFLUOROPROPENE. J. Rud Nielsen, H. H. Claassen, and D. C. Smith. J. Chem. Phys. 20, 1916-19(1952) Dec.

The infrared absorption spectrum of gaseous $CF_2:CF-CF_3$ has been obtained in the region 2 to 38$\mu$, with the aid of LiF, NaCl, KBr, and KRS-5 prisms. The Raman spectrum of both the gaseous and the liquid phase has been photographed with a three-prism glass spectrograph of linear dispersion 15 A/mm at 4358 A, and depolarization ratios have been measured for the stronger bands. A complete assignment of fundamental vibrational frequencies is given, although four of the 21 fundamentals must be regarded as uncertain. The spectra are interpreted in detail. (auth)

1081

THE RAMAN SPECTRUM, STRUCTURE, FORCE CONSTANTS, AND THERMODYNAMIC PROPERTIES OF BROMINE PENTAFLUORIDE. C. V. Stephenson and E. A. Jones. J. Chem. Phys. 20, 1830-4(1952) Dec.

Using a Raman tube made of the plastic polychlorotrifluoroethylene, the Raman spectrum of $BrF_5$ has been obtained. A method has been developed for making polarization measurements when Raman tubes constructed of this plastic are used. The spectrum of $BrF_5$ has been correlated with a tetragonal pyramid configuration with symmetry $C_{4v}$. Force constants were calculated using the Wilson FG Matrix method. The thermodynamic functions for $BrF_5$ were calculated for temperatures ranging from 313.7 to 1500°K, using the rigid rotator, harmonic oscillator approximation. (auth)

1082

SOLUBILITY OF FLUORIDES OF METALS IN LIQUID HYDROGEN FLUORIDE. Albert W. Jache and George H. Cady. J. Phys. Chem. 56, 1106-9(1952) Dec. (cf. NSA 6-2879)

Solubilities of the fluorides of a number of metals in liquid HF have been measured over a temperature range from about -25° to approximately 12°C. In general the values found are in accord with the qualitative information available in the past. Many of the solubilities are of the same order of magnitude as those of the corresponding hydroxides when dissolved in water; however, it appears that in general the fluorides are more soluble. Some fluorides are much more soluble in HF than the corresponding bases are in water. For example, the value for Ag(I) fluoride is $3 \times 10^4$ times that for Ag oxide. (auth)

1083

PHYSICAL PROPERTIES OF LIQUID FLUORINE. Gerard W. Elverum, Jr. and Russell N. Doescher. J. Chem. Phys. 20, 1834-6(1952) Dec.

The viscosity, density, and surface tension of liquid fluorine and their dependence on temperature have been measured. The change in viscosity with temperature indicates that fluorine behaves as a normal liquid in the region studied. The results of the measurement of the density confirm a new much larger value for this property than previously accepted. Measurements of the surface tension given in this paper are in substantial agreement with values reported earlier in the literature if these early values are adjusted by means of the density determinations made by the authors. (auth)

*GRAPHITE*

1084

A STANDARD LABORATORY PROCEDURE FOR THE EVALUATION OF EAST AFRICAN GRAPHITE ORES, WITH SPECIAL REFERENCE TO CRUCIBLE-GRADE FLAKE GRAPHITE. J. H. Harris. Trans. Inst. Mining Met. 62, 43-53 (1952) Nov.

The commercial value of a graphite ore is determined by a flotation process, standardized in the essentials and subject to minor modifications only according to variations in ores tested. A method is proposed for the improvement of flakiness by means of flattening-grinding. A procedure for the determination of carbon in graphite is described in detail. Some specifications for flake graphite are appended. (auth)

*RADIATION CHEMISTRY*

1085

Atomic Energy Project, Univ. of Calif., Los Angeles

QUARTERLY REPORT NO. 1 [ON] DEVELOPMENT OF CHEMICAL SYSTEMS APPLICABLE TO PRODUCTION OF THE ARMY TACTICAL AND ORGANIZATIONAL DOSIMETERS, by George V. Taplin, Clayton H. Douglas, Sanford C. Sigoloff, Donald Wales, Donald Paglia, and Charles Heller. Oct. 1, 1952. 32p. (NP-4272)

During the past quarter the major effort has been successfully directed toward the solution of the problems of rate dependency and heat stability in the chloroform-dye systems of gamma radiation detection. In addition, an extensive study has been made with numerous indicator dyes and with dye mixtures to find an indicator superior to bromcresol purple, and one which would register a series of exposure values by distinct color changes. Finally, a spectrophotometric method of analysis has been developed by which it is possible to determine the amount of radiation exposure in the chloroform-bromcresol purple system with a high degree of accuracy. At this stage of the program, several general, tentative conclusions may be made concerning rate dependency, heat stability, and laboratory calibration of chloroform-dye systems, applicable for measuring initial and contaminating gamma radiations from atomic bomb explosions: The rate factor may be reduced greatly or nearly abolished by using chain-breaking reagents in sufficient amount to reduce the radiation sensitivity of the chloroform-dye system to levels in the range of 0.02 to 0.08 meq acid $\times 10^{-6}$/ml chloroform/r. Several compounds have this property, namely resorcinol, nonyl alcohol, amyl alcohol, alpha naphthol, and others. All of these agents render the chloroform-dye system more heat stable than ethyl alcohol. Re-evaluation of bomb data, together with recent rate studies using large radium and $Co^{60}$ sources, indicate that it now appears possible to produce heat stable (50 to 600 r) gamma-radiation dosimeters which have the features of indicating exposure values relatively independent of dosage rate and air temperature, when used to measure initial or contaminating gamma radiations from atomic bomb explosions. (auth)

1086

STUDIES IN LOW CONCENTRATION CHEMISTRY. II. THE RADIOCOLLOIDAL PROPERTIES OF SILVER-111. George K. Schweitzer and James W. Nehls. J. Am. Chem. Soc. 74, 6186-9(1952) Dec. 20.

A method has been devised for the separation of carrier-free $Ag^{111}$ from irradiated Pd foil based on the formation of radiocolloids in basic solution. The effects of coagulation time, pH, method of removal and the presence of nonaqueous solvents on the formation of these radiocolloids have been determined, and the ability of the radiocolloids to reform after an initial removal has been studied. The results obtained agree with previous observations on radiocolloids of other elements. (auth)

*RADIATION EFFECTS*

1087

THE FAST ELECTRON AND X-RAY DECOMPOSITION OF THE ALKYL HALIDES. Robert H. Schuler, and William H. Hamill. J. Am. Chem. Soc. 74, 6171-4(1952) Dec. 20.

The liquid-phase decomposition of a number of alkyl halides upon exposure to fast electrons and energetic x radiation has been investigated in the region of 0.5 to 2.0 Mv. Alkyl iodides decompose in high yield to free iodine and exhibit considerable radiation-induced exchange with radioiodine present in the system during irradiation. Decomposition of the alkyl bromides yields mainly hydrogen bromide and small amounts of free bromine and is in general complicated by secondary effects. These reactions are sensitive to small amounts of additives present in the reaction. Processes which are peculiar to the radiation chemistry of the system are illustrated, particularly in the decomposition of methyl iodide. (auth)

*RARE EARTHS AND RARE-EARTH COMPOUNDS*

1088

X-RAY-CRYSTALLOGRAPHIC STUDY OF THE HYDROGENATION OF LANTHANUM. Bertrand Dreyfus-Alain. Compt. rend. 235, 1295(1952) Nov. 24. (In French)

Values of relative radii of the La atoms and relative volumes of the metal lattice given in a previous note (NSA 6-6573) are corrected. The increase in specific volume of La caused by hydrogenation, as calculated from measurements on an impure Ce-La sample, is of the order of 15%. The consistency of this figure with x-ray-diffraction data on pure La and La hydride is discussed. (G.Y.)

*SEPARATION PROCEDURES*

1089

[Los Alamos Scientific Lab.]

ENRICHMENT OF CHROMIUM ACTIVITY THROUGH THE SZILARD-CHALMERS SEPARATION, by Milton Kahn, Arthur J. Freedman, and Ernest A. Bryant. [nd] 6p. (AECU-2329)

15-g samples of $K_2CrO_4$ and $K_2Cr_2O_7$ were irradiated in the thermal column of the Los Alamos reactor for 2 hr. Samples of 0.5 g of each were weighed into 15-ml centrifuge cones and dissolved in 8 ml of various aqueous solutions. The solutions were made distinctly acid, 1 ml of Fe(III) carrier solution was added, and the carrier was precipitated as the hydroxide by adjusting the pH to 8.5 with 2f $NH_4OH$. The precipitate was washed once with 10 ml of 0.05f $NH_4Cl$, dissolved in 8 ml of 0.25f $H_2SO_4$ and precipitated again with 2f $NH_4OH$. The precipitate was then dissolved in 0.5f $H_2SO_4$ and counted. Cr activities as great as 30% were recovered from $K_2CrO_4$ and 8% from $K_2Cr_2O_7$. (L.M.T.)

1090

Rensselaer Polytechnic Inst.

THE INFRARED STUDIES OF MOLECULAR REACTIONS OF OXYGEN-CONTAINING SOLVENTS AND PROTON DONORS, by Stephen E. Wiberley, Herbert M. Clark, and Lewis G. Bassett. [nd] 21p. (NYO-609)

Molecular vibration studies were employed to clarify the mechanism of the extraction of inorganic compounds by organic solvents. Since it was felt that solvent extraction falls in the electron donor-acceptor class of reactions, a correlation was sought between the ability of O- or N-containing solvents to accept a proton, i.e., form a hydrogen bond, and to extract inorganic salts. Infrared absorption spectra of HCl and $CHCl_3$ in diethyl or dimethyl ether

dissolved in $CCl_4$ are drawn. The effect of the proton donor on frequencies of the C–O–C bond is discussed. The infrared spectra of $C_2H_5OD$ and $CH_3OD$ also are shown, and the shifts of OD bands in numerous ethers and amines are plotted. Although little correlation with solubility data on salts was found, the results offer additional support for the donor-acceptor mechanism. A further application may lie in assignment of characteristic frequencies of polyatomic molecules by finding which bands are shifted by proton donors. (G.Y.)

1091

Radiation Lab., Univ. of Calif., Berkeley

ION-EXCHANGE COLUMN PERFORMANCE: HYDROGEN CYCLE RATES IN NON-AQUEOUS SOLVENTS, by T. Vermeulen and E. H. Huffman. Oct. 29, 1952. 34p. (UCRL-1989)

Breakthrough histories of a few nonaqueous ion-exchange reactions involving hydrogen ion have been measured in order to calculate the contributory diffusional rates by use of known design-calculation methods and to attempt to interpret these rates. For this purpose, it has been necessary to review the available calculation methods. Diffusivities so determined were found to be less than one-thousandth as large in dry benzene and dry acetone as in water, while the lower alcohols gave intermediate values. Comparison of the diffusion rates with known properties of these solvents suggests that their base strength may be a determining factor. The wide variation observed in the diffusivities indicates that empirical design procedures will be less effective than usual in arriving at practicable operating conditions and that theoretical design principles will be a useful supplement to available experimental measurements. (auth)

1092

SEPARATION OF THE LANTHANONS BY ION EXCHANGE. A COMPARISON OF ELUANTS. R. C. Vickery. J. Chem. Soc., 4357-63(1952) Nov.

A comparison has been made of the efficiencies of various aliphatic carboxylic acids as eluants in separation of the lanthanons by ion-exchange techniques. This comparison indicates that determinations of stability constants for lanthanon complexes can be used to predict the value of the complex-forming agent in ion-exchange separations. Further, when the exchange resin is in the ammonium form, and when high pH values and low flow rates are employed, ethylenediaminetetraacetic acid at low concentrations gives separations of the lanthanons which are better than those obtained under comparable conditions by any of the other eluants studied, including citrate solutions. The use of bivalent ions as separating elements in elutions with ethylenediaminetetraacetic acid has been examined, and with Mn as the separating element this technique has yielded excellent separations of Nd and Pr. Attention is also directed to the necessity of considering molar rather than weight concentrations when comparing eluant efficiencies. (auth)

*SPECTROSCOPY*

1093

Oak Ridge National Lab.

ABSORPTION SPECTRUM OF URANYL SULFATE SOLUTION, by O. Menis and R. Rowan, Jr. July 30, 1952. Decl. Dec. 23, 1952. 10p. (AECD-3480; ORNL-1351)

The absorption spectrum of pure uranyl sulfate solution in the visible and ultraviolet regions has been studied, and plots of absorbancy measurements and of molecular extinction coefficients are presented. (auth)

1094

Oak Ridge National Lab.

ISOTOPE SPECTRUM SHIFT DATA ON URANIUM SPECTRUM LINES, by D. D. Smith. Oct. 6, 1952. Decl. Dec. 19, 1952. 25p. (AECD-3481; ORNL-1412)

Isotope-shift data on more than 400 lines of the U emission spectra are tabulated. (auth)

1095

Donner Lab., Univ. of Calif., Berkeley

INFRARED SPECTRA OF SOME LIPOPROTEINS AND RELATED LIPIDS, by N. K. Freeman, F. T. Lindgren, Y. O. Ng, and A. V. Nichols. Donner Lab., Univ. of Calif., Berkeley and Radiation Lab., Univ. of Calif., Berkeley. Nov. 11, 1952. 15p. (UCRL-2004)

The infrared absorption spectra of some ultracentrifugally isolated serum lipoproteins and those of some related lipids are presented and discussed. In a lipoprotein spectrum the relative intensities of the ester carbonyl band and certain strong bands of proteins can serve as a rough gage of the lipid/protein ratio. Other absorption bands are correlated with those of the principal component molecules making up the lipoprotein. A rudimentary method for quantitative analysis of these molecules and of lipid mixtures by infrared methods are described. Needed improvements are suggested. (auth)

1096

THE INFRARED SPECTRUM OF CHLORINE DIOXIDE. Alvin H. Nielsen and P. J. H. Woltz. J. Chem. Phys. 20, 1878-83(1952) Dec.

The infrared spectrum of $ClO_2$ has been reinvestigated from 2 to 40$\mu$. Several new bands have been discovered, among them the bending frequency $\nu_2$ at 445 $cm^{-1}$. This band has the doublet character required if the molecular model is to be an obtuse triangle in accord with electron diffraction experiments. Three bands, $\nu_1$, $\nu_2$, and $2\nu_1$, were resolved with prism and grating methods, and the spacing of the Q lines was found to be about 3.0 $cm^{-1}$. An $A''-B''$ value of 1.413 $cm^{-1}$ was obtained from the analysis of $\nu_2$, and this value also is in excellent agreement with the electron-diffraction measurements. Moments of inertia computed from the r (Cl–O) = 1.49 A and $2\alpha$ (apex angle) = 118.5° obtained from a combination of electron-diffraction and infrared data are $I_A = 16.09 \times 10^{-40}$ g $cm^2$, $I_B = 86.34 \times 10^{-40}$ g $cm^2$, and $I_C = 102.43 \times 10^{-40}$ g $cm^2$. A band which cannot be ascribed to an impurity was found at 290 $cm^{-1}$. The possibility that this band results from polymerization of $ClO_2$ is suggested. (auth)

1097

THE MICROWAVE SPECTRUM OF VINYLACETYLENE. H. W. Morgan and J. H. Goldstein. J. Chem. Phys. 20, 1981(1952) Dec.

The pure rotational spectrum of vinylacetylene has been investigated in a Stark-effect microwave spectrograph in the region about 27,000 Mc. Five weak lines, comprising the $J = 2 \rightarrow 3$ grouping, were identified. The lines and calculated rotational constants are listed. (G.Y.)

1098

MASS SPECTRA OF FLUOROCARBONS. Fred L. Mohler, Vernon H. Dibeler, and R. M. Reese. J. Research Nat'l Bur. Standards, 49, 343-7(1952) Nov.

Mass spectra of 22 fluorocarbons have been measured on a 180° Consolidated mass spectrometer, and the results are presented in six tables of spectral data. These include seven normal paraffins from methane to heptane; isopentane and isohexane; three pure cyclics and methylcyclohexane; four olefins; three $C_4F_6$ isomers; a dicyclic; and a tricyclic. These spectra are very different from the hydrocarbon analogs. In all the paraffins the most abundant ion is $CF_3^+$, and the molecule ions are very small or absent. Spectra of the unsaturated compounds and the cyclics are more distinctive than the normal paraffins. In the paraffins, ions of formula $C_nF_{2n+1}$ tend to be largest, except that when one

carbon is removed the largest ion is $C_nF_{2n-1}$. In cyclics, $C_nF_{2n-1}$ ions tend to be largest; in the dicyclic, $C_nF_{2n-3}$ ions are largest; and in the tricyclic, $C_nF_{2n-5}$ ions tend to be largest. The tricyclic $C_8F_{12}$ is probably a fused cyclobutane structure. The dicyclic is completely fluorinated methylnapthalene, $C_{11}F_{20}$, and is the heaviest compound ever run on the Bureau's mass spectrometer. In the perfluoroparaffins there is a progressive increase in the current per unit pressure for the $CF_3^+$ ion with increasing molecular weight of the fluorocarbon. In incompletely fluorinated molecules containing an H atom the larger ion peaks containing H will correspond with the larger peaks in the perfluoro spectrum, with H substituted for a fluorine atom. (auth)

*SYNTHESES*

1099

A SYNTHESIS OF ISONICOTINIC ACID BY HALOGEN-METAL EXCHANGE AND ITS APPLICATION TO THE PREPARATION OF ISONICOTINIC-$C^{14}$ ACID HYDRAZIDE. Arthur Murray, III and Wright H. Langham. J. Am. Chem. Soc. 74, 6289-90(1952) Dec. 20.

*TRACER APPLICATIONS*

1100

KINETICS OF THE EXCHANGE OF $N^{15}$ BETWEEN $N^{15}O_2$ AND $N_2O_5$. Alexander R. Amell and Farrington Daniels. J. Am. Chem. Soc. 74, 6209-12(1952) Dec. 20.

The rate of the exchange reaction $N^{15}O_2 + N_2O_5 \rightarrow NO_2 + N^{15}NO_5$ in the gas phase has been followed at −9, 0, and 10°C using chemical separations and a mass spectrometer. The equation $k = 6.0 \times 10^{12}\ e^{-19,000/RT}$ can be used to express the experimental data. The agreement between this reaction rate and that for the reaction between nitrogen pentoxide and nitric oxide leads to the conclusion that the first step in both reactions is the bond-breaking step $N_2O_5 \rightarrow NO_2 + NO_3$. No effect of total pressure on the specific rate constants for isotopic exchange at low pressures was found, but no conclusions can be drawn concerning the existence of a pressure effect. Qualitative experiments are described in which the rate of decomposition of nitrogen pentoxide is increased by several gaseous reducing agents, as well as by nitric oxide. (auth)

1101

THE SOLVENT EXTRACTION OF GROUP IIIB METAL HALIDES. H. M. Irving and F. J. C. Rossotti. Analyst 77, 801-12(1952) Nov.

With the aid of tracer $Ga^{72}$, $In^{114}$, and $Tl^{204}$, the ether extraction of Ga bromide and iodide, In chloride and iodide, thallic iodide, and thallous chloride, bromide, and iodide from the corresponding halogen acids has been studied for a range of acid normalities. Liquid counting was used throughout. Although a simple density correction proved adequate with the pure $\beta$ emitter $Tl^{204}$, a special procedure had to be devised for Ga and In to correct for variations in the counting rate with changes in the average atomic number of the nuclear species present in solution. The extraction by ether of ferrous and Be iodides from 1.5M hydriodic acid was found to be essentially zero, so that a simple procedure for the determination of In in the presence of Ga, Fe, and Be, among other metals, can be based on the solvent extraction of In iodide. (G.Y.)

*URANIUM AND URANIUM COMPOUNDS*

1102

THE VAPOUR PRESSURE OF AQUEOUS SOLUTIONS OF BERYLLIUM SULPHATE AND OF URANYL SULPHATE AT 25°. R. A. Robinson. J. Chem. Soc., 4543-4(1952) Nov.

Isopiestic vapor-pressure measurements of aqueous $BeSO_4$ and $UO_2SO_4$, from which osmotic and activity coefficients were calculated, indicate that these salts do not show anomalous behavior in solution with respect to other bivalent metal sulfates. (G.Y.)

1103

METAL-HYDROGEN SYSTEMS. III. THE URANIUM-HYDROGEN SYSTEM. Thomas R. P. Gibb, Jr., James J. McSharry, and Henry W. Kruschwitz, Jr. J. Am. Chem. Soc. 74, 6203-7(1952) Dec. 20.

The dissociation pressure of $H_2$ over U hydride has been studied as a function of temperature and composition of the solid solution in regions where the isotherms show a marked upward inflection. Observations are reported for the range 500 to 4900 cm at temperatures from 357 to 650°C for compositions ranging from $UH_{2.85}$ to $UH_{3.00}$. The equation for $UH_{3.00}$ is: $\log P_{cm} = (-1730/T) + 5.78$, where T is absolute temperature. Withdrawal of H from the solid phase causes a marked decrease in the dissociation pressure. After removal of several tenths of a mole of H, the solid phase reverts to normal behavior, showing a heat of dissociation of 20.5 kcal/mole $H_2$, and $\Delta F_{298} = 11.8$ kcal/mole $H_2$. (auth)

# ENGINEERING

*HEAT TRANSFER AND FLUID FLOW*

1104

Lewis Flight Propulsion Lab., NACA

LAMINAR NATURAL-CONVECTION FLOW AND HEAT TRANSFER OF FLUIDS WITH AND WITHOUT HEAT SOURCES IN CHANNELS WITH CONSTANT WALL TEMPERATURES, by Simon Ostrach. Dec. 1952. 55p. (NACA-TN-2863)

An analysis of the natural-convection phenomenon shows that the flow and heat transfer, in general, not only are functions of the Prandtl and Grashof numbers but also depend on a new dimensionless parameter. If this parameter is not negligibly small, the compression work and frictional heating may appreciably affect this mode of heat transfer. Particular consideration is given to the fully developed natural-convection flow of fluids with and without heat sources between two long parallel plane surfaces whose temperatures are maintained constant but not necessarily equal. Detailed velocity and temperature distributions are obtained from which the effects of heat sources in the fluids and frictional heating on the process can be seen. Frictional heating and heat sources increase the velocities and temperatures. Increasing the ratio of the two wall-temperature differences (wall minus outside ambient) also leads to similar results. (NACA)

1105

STABILITY AND ACCURACY OF NUMERICAL SOLUTIONS OF THE HEAT FLOW EQUATION. P. H. Price and M. R. Slack. Brit. J. Applied Phys. 3, 379-84(1952) Dec.

The merits of different finite-difference representations of the heat flow equation and a convection boundary condition equation are discussed in terms of the stability and accuracy of the solutions they yield. A new method of deriving a condition for stability is given. This is applied to examples of heat conduction involving variable thermal diffusivity and heat transfer by convection at the surface. Some finite-difference forms of this boundary condition impose stability criteria which are stricter than, or additional to, that required in the case of a prescribed surface temperature. A new finite-difference representation of the surface-heat flux equation is discussed. The accuracy of the various finite-difference schemes is investigated by comparing both their analytical and numerical solutions with analytical solutions of the differential equation of heat flow. (auth)

1106
THE COMPARISON BETWEEN THE LONGITUDINAL CORRELATION AND THE TIME CORRELATION IN A TURBULENT FLOW. F. N. Frenkiel. Phys. Rev. 88, 1380-2(1952) Dec. 15.

Some preliminary applications of high-speed computing to the analysis of experimental data on turbulence are reported. A time-correlation curve is determined from a recording of velocity fluctuations measured with a single hot-wire anemometer. The shape of the time-correlation curve differs from the shape of the longitudinal correlation curve measured in the same fluid flow. One must, therefore, be cautious in reaching conclusions from experiments based on the assumption that time and space spectra of turbulence are identical. A more extensive study of the relation between time and space characteristics of turbulence is in process. (auth)

*TRACER APPLICATIONS*

1107
RADIOISOTOPES IN PROCESS INSTRUMENTATION. J. Kohl. Chem. Eng. Progress 48, 611-16(1952) Dec.

This report summarizes the application of radioisotopes to various process instrumentation problems. For some of the problems, the type, quantity and properties, and approximate cost of the radioisotope are included, along with the instrumentation requirements and typical results. (cf. NSA 6-2985). 27 references.

# MINERALOGY, METALLURGY, AND CERAMICS

*CERAMICS AND REFRACTORIES*

1108
Battelle Memorial Inst.
AN APPRAISAL OF THE SINTERING BEHAVIOR AND THERMAL EXPANSION OF SOME COLUMBATES, by E. A. Durbin and C. G. Harman. Dec. 15, 1952. 14p. (BMI-791)

The mean coefficient of thermal expansion, for the range of 25 to 600°C, of $Nb_2O_5$, $Ta_2O_5$, $TiO_2 \cdot Nb_2O_5$, $Al_2O_3 \cdot Nb_2O_5$, and a solid solution of $ZrO_2+3Nb_2O_5$ were 0.0, 1.5, 2.1, 2.9, and $0.9 \times 10^{-6}$ per degree Centigrade, respectively. The materials, when sintered in air at temperatures between 1370 and 1440°C, had low porosities and appeared to be stable in air, even at elevated temperatures. (auth)

1109
Battelle Memorial Inst.
PROPERTIES OF SOME COLUMBIUM OXIDE-BASIS CERAMICS, by E. A. Durbin, H. E. Wagner, and C. G. Harman. Dec. 15, 1952. 15p. (BMI-792)

Niobium pentoxide and compositions in the binary systems of $Nb_2O_5$ and $Al_2O_3$, $ZrO_2$, MgO, or $TiO_2$ were sintered into sound forms having apparent porosities ranging from 5 to 16 per cent. In general, these bodies were characterized by unusually low values of thermal expansion and modulus of elasticity, large increases in strength with temperature, and small increases of modulus of elasticity with temperature. (auth)

1110
Pennsylvania State Coll. School of Mineral Industries
TECHNICAL REPORT NO. 51 ON THE APPLICATION OF THE POLARIZATION THEORY TO CERAMIC PROBLEMS, by John W. Lindenthal. May 1952. 75p. (NP-4045; Technical Report No. 51; U22551)

Electrical conductances and flow properties were investigated for suspensions of quartz powder (potter's flint) in $H_2O$ and aqueous solutions. The relative-conductance curves for both distilled and $SiO_2$-saturated $H_2O$ containing glycerol (G) exhibited broad maximums between 20 and 40% G; values for the distilled-$H_2O$ mixtures were consistently higher. The conductances of slurries of $SiO_2$, $TiO_2$, and $Al_2O_3$ increased with increasing amounts of oxide; initial additions were the most influential. The addition of potter's flint to G-$SiO_2$-saturated $H_2O$ mixtures increased the conductance, but these increases became less as the content of G increased. Similar curves showing an initial decrease followed by an increase in conductance were obtained for slurries of potter's flint in HCl and NaOH solutions; the increase was most pronounced at low HCl and NaOH concentrations. Cones made from $H_2O$ slurries of potter's flint containing 5 to 30% G slumped more easily than those of pure $H_2O$. Cones of the NaOH solution were sticky and soft and tended to slump under their own weight; cones from HCl showed no tendency to slump under their own weight but collapsed abruptly with vibration. The quartz-$H_2O$ behavior was attributed to ionization of the $H_2O$ by quartz to $OH^-$ and hydrated protons and adsorption of the $OH^-$ by $SiO_2$ to yield particles with a negative charge. On the addition of G, the OH groups of G screened the $Si^{+4}$; the molecules of G coordinated the particle surfaces and decreased the amount of $H_2O$ to be ionized. The interpretation for the quartz-$H_2O$ system applied to suspensions of solid particles in $H_2O$ appeared to explain electrokinetic phenomena, the origin of particle charges, the solubility of particles, resistance to flow, and shrinkage and green strength on drying. The reaction of G with complex organic compounds, suggested a possible method of removing oil from a shale. (TID-LC)

*CORROSION*

1111
Battelle Memorial Inst.
CORROSION BY MOLTEN BISMUTH, by H. A. Pray, R. S. Peoples, and W. K. Boyd. Oct. 15, 1952. 23p. (BMI-773)

The corrosion of some 50 materials (representing low-alloy steels, transformer-grade silicon steels, stainless steels, and super heat-resistant alloys) has been determined by static tests in molten bismuth at 750 and 850°C. Evaluation of the alloys was made on the basis of visual appearance, analysis of the bismuth after test, and metallographic examination of the tested samples. Armco iron, SAE 1003, 1010, and chromium plate were severely attacked, while the low-chromium alloys, high-chromium irons, stainless steels, and heat-resistant alloys were wet by the bismuth and moderately attacked. In general, the corrosion appeared to be the most severe at or near the liquid-vapor interface. Of the alloys tested, only the 2.9% silicon transformer steels and Duriron were considered to have exhibited good corrosion resistance to molten bismuth at either 750 or 850°C. (auth)

1112
Babcock and Wilcox Co.
EROSION AND CORROSION STUDIES OF LIQUID METAL SYSTEMS; INVESTIGATION OF CONSTANT TEMPERATURE, FORCED CIRCULATION LIQUID LITHIUM SYSTEMS; TECHNICAL REPORT III, by A. W. Dana, Jr., O. H. Baker, and M. Ferguson. Aug. 21, 1952. 73p. (DC-52-5-19; Technical Report No. 3)

This report summarizes the construction, operation, and metallurgical and chemical examinations of seven essentially constant-temperature, forced-circulation lithium loops. Lithium was circulated at the approximate temperatures of 960, 1400, 1500 and 1600°F, with velocities up to 55 ft/sec. The container material was 25 Cr-20 Ni stainless alloy. Testing time varied with the temperature of operation from approximately 1000 hours for the three lowest temperatures

to 369 and 564 hours for the two highest temperatures. Corrosion appeared to be of the general-solution type with indications of preferential attack of sigma particles. Metal transport occurred in the loops operated over 1400°F. Metal transport was of such severity that plugging with metal crystals terminated the runs at 1600°F, before the desired 1000 hours test duration was obtained. (auth)

*GEOLOGY AND MINERALOGY*

1113

Division of Raw Materials, AEC

INTERIM REPORT ON THE ORE DEPOSITS OF THE GRANTS DISTRICT, NEW MEXICO, by Irving Rapaport. Issued Nov. 1952. 19p. (RMO-1031)

The Grants uranium district is situated in northwest New Mexico, along the southern flank of the San Juan Basin, between the cities of Gallup and Albuquerque. U mineralization appears to be confined chiefly to Jurassic rocks. Known mineralization is restricted to two general horizons: (1) The Todilto limestone and basal Summerville, and (2) the Morrison and basal Dakota formations. Mineralization in the Todilto limestone is known to extend in an east-west direction over a distance of 60 miles. Deposits in the upper, sandstone horizon have been discovered over a linear extent of 85 miles in the same direction. Uranium minerals of the ore deposits in the Todilto limestone include carnotite, tyuyamunite, uranophane, beta-uranotile, sklodowskite, and pitchblende. Carnotite and schroeckingerite have been identified in the Morrison formation where they are associated with organic material and limonite. The sequence of geologic events that has determined the present form and position of the ore deposits is discussed, and guides to ores are given. (G.Y.)

1114

Geological Survey

NOTES ON THE DIFFERENTIAL LEACHING OF URANIUM, RADIUM, AND LEAD FROM PITCHBLENDE IN $H_2SO_4$ SOLUTIONS, by George Phair and Harry Levine. Sept. 1952. 23p. (TEI-262)

Two 5-lb samples from the "hot spot" of the pyritic dump of the Wood mine, a past producer of pitchblende near Central City, Colo., showed Ra/U ratios that were abnormally high but nearly constant at about 150 times the equilibrium value for both samples in spite of a sevenfold difference in uranium contents. Analyses of oxidized but still black Katanga pitchblende before and after leaching in very dilute, dilute, and concentrated sulfuric acid solutions showed that $UO_3$ is preferentially leached with respect to $UO_2$, Ra, and Pb in all three solutions, that the resulting residual concentration of both radium and lead effected in the process is proportional to the total amount of uranium leached except in concentrated $H_2SO_4$, and that after leaching in concentrated $H_2SO_4$ the resulting residual concentration of radium relative to lead is much lower, as might be expected from data published by Lind, Underwood, and Whittemore in 1918 for the solubility of $RaSO_4$. Under similar leaching conditions unaltered pitchblende from Great Bear Lake lost only $\frac{1}{10}$ to $\frac{1}{15}$ as much uranium as the $UO_3$-rich Katanga ore. Both laboratory and field results point to the same conclusion, that in an oxidizing, highly acid environment uranium is rapidly leached and both radium and lead tend to be fixed approximately proportionally in the process. These results help to explain why $UO_3$-rich uranium minerals tend to give maximal Pb/U ages and why the search for high-grade uranium ore in and around abandoned sulfide mines known to have produced pitchblende in the past has been consistently disappointing. (auth)

1115

URANIUM IN THE CLAY OF A BLACK RADIOACTIVE SHALE. James H. Brown, Jr. and W. D. Keller. Science 116, 632-3(1952) Dec. 5.

The results of a brief study of a black radioactive shale from Ste. Genevieve Co., Mo., show that the U contained in it is located predominantly in a relatively fixed condition in the fine clay fraction, and not in the black organic matter. This result is at variance with recent suggestions that the U in black shales is more likely attached to the organic matter. Leaching experiments were conducted to determine the ease of removal of the U. HCl, $HNO_3$, $H_2SO_4$, aqua regia, and dilute $Na_2CO_3$ were effective solvents, but hot and cold $H_2O$, ethyl alcohol, $CS_2$, and $CCl_4$ did not extract enough U from 2 g of shale to produce fluorescence. Propyl alcohol dissolved a small amount of U. Attempts to exchange the U cationically indicated that the U is held by the clay minerals in a not easile exchangeable condition. (G.Y.)

1116

GEOLOGICAL AGE DETERMINATION BY THE POTASSIUM-ARGON METHOD. K. Fritze and F. Strassmann. Naturwissenschaften 39, 522-3(1952) Nov. (In German)

The A content in a sample of Varuträsk, Sweden, microcline having a K content of 10.6 ± 0.1% was found to be 0.92 ± 0.03 $mm^3/g$, corresponding to an age of $1.88 \times 10^9$ or $2.29 \times 10^9$ yr, depending on the $K^{40}$ half life. (G.Y.)

1117

RADIOACTIVE MEASUREMENTS IN GEOLOGY. II. MEASURING INSTRUMENTS. III. PRACTICAL APPLICATIONS. H. v. Buttlar and I. Wendt. Arch. tech. Messen, 251-4(1952) Nov. (In German)

A brief review of instruments and techniques used in prospecting, petroleum studies, age determinations, sedimentation-velocity investigations, etc., is presented. (NSA 7-574 covers pt.I) (G.Y.)

1118

SUCCESSES IN SEARCH FOR URANIUM IN THE COMMONWEALTH. C. F. Davidson. New Commonwealth 24, 515-18 (1952) Nov. 24.

A summary is given of various searches for U ores in the British Commonwealth during the past 7 or 8 years. In Canada over 560 U prospects with more than 0.05% U oxide have been discovered, the most important discoveries being in the Goldfields region of Saskatchewan. The development of the industry of U recovery from some S. Africa gold mines is discussed. Two important deposits have been found in Australia, the Rum Jungle deposit near Darwin, and the Radium Hill deposit, 200 miles northeast of Adelaide. A recent find of high-grade ore in northern Rhodesia is reported, along with the already-publicized discovery in Nigeria of a large low-grade source of niobium with by-product U. (L.M.T.)

*METALS AND METALLURGY*

1119

Iowa State Univ.

PROGRESS REPORT OF THE RESEARCH PROJECT IN METALLURGY ON THE STRUCTURES AND PROPERTIES OF INTERMETALLIC COMPOUNDS FOR THE PERIOD MARCH 1, 1952 TO NOVEMBER 30, 1952, by N. C. Baenziger, J. W. Nielsen, and E. J. Duwell. Dec. 1, 1952. 6p. (AECU-2279)

Measured magnetic susceptibilities of five $MZn_{13}$ compounds, where M is K, Ba, Sr, Ca, or Na are listed and discussed. Crystal-structure data available to date on the Na-Hg, K-Hg, $NH_4$-Hg, Rb-Hg, Be-Zr, and Be-Si-Zr systems are summarized. (G.Y.)

1120
Battelle Memorial Inst.
THE EFFECT OF PURIFICATION ON WELDS IN MOLYBDENUM, by W. H. Kearns, E. Eichen, D. C. Martin, and C. B. Voldrich. Dec. 1, 1952. 26p. (BMI-788)

The causes of brittleness in molybdenum weldments and procedures for making ductile welds in molybdenum are being studied. It has been found that the oxygen and nitrogen contents of commercial powder-metallurgy molybdenum can be lowered by heating it at 3500°F or above for several hours in a high vacuum. This solid-state-purified molybdenum is ductile at room temperature at a strain rate of 0.064 per second. Ductile upset welds can be made in purified molybdenum when welding is done in high vacuum. Welds made in purified molybdenum in vacuum above one micron, dry tank hydrogen, or dry tank helium are brittle. (auth)

1121
North American Aviation, Inc.
ON THE NATURE OF RADIATION DAMAGE IN METALS, by J. A. Brinkman. Issued Dec. 22, 1952. 32p. (NAA-SR-198)

The nature of the permanent damage retained in metals from irradiation has been investigated in somewhat greater detail than has been done in the past. The usual assumption has been that the damage in all metals consists chiefly of interstitial-vacancy pairs. The model presented in this paper reduces to this picture for the light elements, but introduces a new concept in the case of damage in the heavy metals, called a displacement spike. Calculations are made from which one can estimate the relationship between the density of interstitial-vacancy pairs and the temperature of the associated thermal spike. An assumption regarding the extent to which interstitial-vacancy pairs persist throughout the duration of the thermal spike has been made, based upon these calculations. The number of interstitial-vacancy pairs predicted in the heavy elements is considerably smaller than that predicted by the former model. A mechanism is proposed by which small dislocation loops can be produced in the heavier metals by irradiation. (auth)

1122
Armour Research Foundation
FINAL REPORT [ON] DEVELOPMENT OF PROTECTIVE COATING FOR TITANIUM AND TITANIUM ALLOYS [FOR] JUNE 1, 1951–AUGUST 31, 1952, by John N. Reding, William H. Colner, Morris Feinleib, Howard T. Francis, and R. A. Lubker. Sept. 16, 1952. 16p. (NP-4210; WAL-401/46-16)

Methods for obtaining adherent electrodeposits on titanium were investigated. Excellent adherence of copper electrodeposits was achieved by subjecting titanium to an anodic etch in a bath based on HF and ethylene glycol. Operating variables are discussed; they can be adjusted to give electropolished as well as etched surfaces. The bond between plate and basis metal appears to be mechanical. Lesser adherence was obtained by a cathodic treatment in a "zinc strike" based on HF and ethylene glycol. (auth)

1123
Utah Univ.
HIGH PRESSURE OXIDATION OF METALS. II. TANTALUM, by William McKewan and W. Martin Fassell, Jr. Sept. 25, 1952. 17p. (NP-4243; Technical Report No. 2)

Tantalum samples were oxidized in pure $O_2$ at temperatures of 500 to 600°C. The pressure was varied from 14.7 to 500 psi. The linear law was observed in every case. An Arrhenius plot was made of the data at 14.7 psi and two activation energies were determined, 77.7 kcal/mole from 500 to 540°C and 46.1 kcal/mole from 540 to 600°C. The oxidation rate was found to vary directly with the pressure according to the equation $k = (0.297P + 10.0)$ mg/cm$^2$/hr, where P is in atmospheres. A mechanism was proposed involving a constant thickness film on the surface of the metal. This mechanism appears to explain the experimental data and the pressure effect. (auth)

1124
Utah Univ.
PROGRESS REPORT NUMBER II [ON] THE HIGH TEMPERATURE OXIDATION OF METALS [FOR] FEBRUARY 29 TO JUNE 1, 1952. June 1, 1952. 11p. (NP-4245; Progress Report No. 2)

Data are presented on the high pressure oxidation of Ta, in which the oxidation rate in the linear region is shown to vary directly as the $O_2$ pressure. Preliminary studies of the effect of pressure on the high temperature oxidation of Zr are reported. (C.R.)

1125
Utah Univ.
PROGRESS REPORT NUMBER III [ON] THE HIGH TEMPERATURE OXIDATION OF METALS [FOR] JUNE 1 TO SEPTEMBER 26, 1952. Sept. 26, 1952. 12p. (NP-4246; Progress Report No. 3)

Oxidation rates of Zr were determined in the temperature range of 600 to 946°C at one atm pressure of O. In this temperature and pressure range the uptake of O by Zr was found to follow an overall parabolic equation. Rate constants are presented in tabular form. Preliminary studies of the oxidation of Ti are reported. (C.R.)

1126
Climax Molybdenum Co., of Mich.
THIRD ANNUAL REPORT [ON] ARC-CAST MOLYBDENUM BASE ALLOYS, by M. Semchyshen and Harold E. Hostetter. 1952. 210p. (NP-4277)

The most significant progress resulting from research on arc-cast molybdenum-base alloys during the third contract year is summarized. Wrought Mo-base alloys fabricated by conventional commercial methods were shown to have good ductility and exceptionally high strength in stress-rupture tests at 1600 to 2000°F. These wrought alloys were found to have recrystallization temperatures significantly higher than unalloyed Mo, such that the increased strength resulting from hot-cold working was appreciable in some of the alloys, even after 200 hours at 1800°F in the stress-rupture test. It was established that misch metal or other combinations of rare earth elements can be used to supplant, or to supplement, other deoxidizers to produce forgeable ingots of Mo and Mo-base alloys. Certain microstructures (speckling) appearing on intergranular fracture surfaces of Mo and Mo-base alloys were found to have some correlation with forgeability. It was shown that good recovery in the initial forging of ingots was favored by the following conditions: (a) a fine, machined surface finish, (b) a hydrogen atmosphere for heating, (c) use of a 60°-V as the bottom die instead of a 90°-V or a flat die, and (d) intermediate annealing. Additions of Al or of Th were shown to have promise in minimizing embrittlement of worked Mo and Mo-base alloys annealed at temperatures up to 3900°F. (auth)

1127
Columbia Univ. School of Mines
PROGRESS REPORT [ON] THE STUDY OF DIFFUSIONLESS PHASE CHANGES IN SOLID METALS AND ALLOYS FOR JUNE 1 TO AUGUST 31, 1952, by T. A. Read, M. W. Burkart, M. Wechsler, D. S. Lieberman, and C. W. Chen. [nd] 7p. (NYO-937)

A brief report is made on the transformation behavior of In-Tl and Al-Cu-Ni alloys. (J.E.D.)

1128
Oak Ridge National Lab.
MAKING SMALL HOLES, by John R. Sites. Nov. 10, 1952. 8p. (ORNL-1447)

A simple method for making small holes of the order of

0.001 inch in thin metal is described. A common sewing needle is used as a tool with a finely machined piece of steel as an anvil. The very thin center of the dimple, so formed, is then worn through by slight rubbing on the anvil. (C.R.)

1129

Office of Technical Services, Dept. of Commerce
BIBLIOGRAPHY OF REPORTS ON PROTECTIVE COATINGS FOR METALS. July 1950. 21p. (SB-2(rev.))

1130

ELECTRON-MICROSCOPIC INVESTIGATION OF THE SURFACE OF STRETCHED PURE ALUMINUM. I. Heinz Wilsdorf and Doris Kuhlmann-Wilsdorf. Z. angew. Physik 4, 361-70(1952) Oct. (In German)

The surface of Al stretched 0.5 to 64% was studied with an electron microscope, a new preparation technique being used. A very fine step structure covering the entire surface outside the glide bands was observed. This is considered to be an elementary structure. The development of glide bands was followed by photographs and band counting. (tr-auth)

1131

THE TEMPERATURE DEPENDENCE OF TRANSIENT AND SECONDARY CREEP OF AN ALUMINIUM ALLOY TO BRITISH STANDARD 2L42 AT TEMPERATURES BETWEEN 20° AND 250°C, AND AT CONSTANT STRESS. A. E. Johnson and N. E. Frost. J. Inst. Metals 81, 93-107(1952) Oct.

The effects of temperature on the various phases (transient and steady-state creep) of forward creep and on creep recovery have been investigated for an Al alloy to British Standard 2L42 (R.R.59), by means of creep tests in pure torsion on thin-walled tubular specimens at a constant stress of 2 tons/in$^2$, and at 50°C intervals over the range 20 to 250°C. The tests were of moderately long duration. It is concluded that for this alloy no current fundamental theory adequately describes the transient creep between 20 and 250°C, although up to 200°C the secondary creep rates agree quite well with theories based on the Eyring process rate conception. Superposition theories do not represent the recoverable creep measured. The total forward creep is well represented at all temperatures by an equation $\gamma = K_1 t^{1/m_1} + K_2 t_{m_2}$, where $K_1$ and $1/m_1$ refer to the non-recoverable portion of the forward creep strain, and $K_2$ and $1/m_2$ refer to the recoverable portion of the creep. $K_1$, $K_2$, and $1/m_1$ vary with temperature; $1/m_2$ is effectively constant. (auth)

1132

EQUILIBRIUM RELATIONS AT 460°C IN ALUMINIUM-RICH ALLOYS CONTAINING 0-7% COPPER, 0-7% MAGNESIUM, AND 1.2% SILICON. H. J. Axon. J. Inst. Metals 81, 209-13(1952) Dec.

The equilibrium isothermal at 460°C is given for quaternary alloys rich in Al and containing 0 to 7% Mg, 0 to 7% Cu, and constant Si (1.2%). The phases encountered are the Al-rich solid solution, $CuAl_2$, $Mg_2Si$, Si, the ternary phase $Al_2CuMg$, and a quaternary phase which probably has the composition $Al_5Cu_2Mg_8Si_6$. These phases give rise to fourteen separate phase fields. A new 460°C isothermal for the Al-rich region of the Al-Cu-Si system is also given. (auth)

1133

THE SUB-GRAIN STRUCTURE IN ALUMINIUM DEFORMED AT ELEVATED TEMPERATURES. J. A. Ramsey. J. Inst. Metals 81, 215-16(1952) Dec.

Sub-grain structures in coarse-grained Al deformed at elevated temperatures are shown by metallographic and x-ray examination to be associated with bands similar to kink bands. A marked resemblance thus exists between these sub-grain structures and those resulting from heating after straining at room temperature. (auth)

1134

ALUMINUM POWDER PRODUCTS COMPARED. E. Gregory and N. J. Grant. Iron Age 170, No. 26, 69-73(1952) Dec. 25.

Aluminum products made from three grades of sintered Al powder were tested in creep-rupture at temperatures from 400 to 900°F for times up to 1000 hr. Included were a coarse atomized grade, M-255, and two types of flake powder with different oxide contents, M-257 and SAP. Materials made from the flake products show unusually good high-temperature stability. Extreme gains in rupture life and creep resistance are achieved by use of the powdered Al products as compared with conventional forged and cast Al alloys. (auth)

1135

NATURE OF THE LINE MARKINGS IN TITANIUM AND ALPHA TITANIUM ALLOYS. C. M. Craighead, G. A. Lenning, and R. I. Jaffee. J. Metals (N.Y.) 4, 1317-19(1952) Dec.

Line markings in high-purity iodide Ti, commercial purity Ti, and high-purity $\alpha$ alloy containing 0.2% N are shown. Appearance of the iodide Ti after various metallurgical operations and after absorption at 700°C of 0.3 at.% H is shown. Phase studies of the Ti-H system are reported. (L.T.W.)

1136

PLASTIC DEFORMATION OF COARSE-GRAINED ALUMINIUM. V. M. Urie and H. L. Wain. J. Inst. Metals. 81, 153-9(1952) Nov.

A fine grid, photographically reproduced on the specimen surface, has been used to measure local elongations in the individual grains of deformed specimens of coarse-grained Al. In agreement with previous workers, it has been found that the elongation varied from grain to grain and within the individual grains of the aggregate. The elongation was generally restricted in the vicinity of grain boundaries, and the form of the restriction appeared to depend on the orientation relationships between neighboring grains. The occurrence of deformation bands in the specimen during elongation produced corresponding fluctuations in the elongation curves which increased in magnitude with the over-all elongation of the specimen. (auth)

1137

THE VISCOSITY OF ALUMINIUM AND BINARY ALUMINIUM ALLOYS. W. R. D. Jones and W. L. Bartlett. J. Inst. Metals 81, 145-52(1952) Nov.

An apparatus, based upon the outer-rotating-cylinder method, has been constructed to study the variation of viscosity with temperature for pure Al and its variation with temperature and composition for a number of binary Al alloys. The results show that Al and its alloys exhibit a characteristic change point on their viscosity/temperature curves at 760 to 770°C, which appears to be due to some change of state in the liquid. For the binary alloys, the viscosity varies in accordance with the equilibrium diagram, there being a maximum at the limit of solid solubility and a minimum at the eutectic. Modification increases the viscosity of the eutectic Al-Si alloy by about 30% and either eliminates, or raises the temperature of, the change point on the viscosity/temperature curve. (auth)

1138

THE RECOVERY OF POLYCRYSTALLINE ALUMINIUM. J. A. Ramsey. J. Inst. Metals 81, 61-6(1952) Oct.

The recovery of polycrystalline Al has been studied both by x rays and microscopically. X-ray examination showed that only a few grains in a polycrystalline specimen recovered to a great extent; the majority recovered only partially. Microscopic examination revealed that recovery depended on the presence of kink bands, the degree of recovery in a given grain being contingent on the closeness of packing of the kink bands. If the bands were sufficiently closely packed, the interband material as well as the bands themselves recovered. An interpretation of the results is given in terms of the dislocation hypothesis. On the basis of the results obtained,

some criticisms are made of Cahn's theory of polygonization. (auth)

1139

THE CONSTITUTION OF TANTALUM-TITANIUM ALLOYS. D. Summers-Smith. J. Inst. Metals 81, 73-6(1952) Oct.

The Ta-Ti system has been investigated by metallographic and x-ray methods, using alloys prepared from van Arkel Ti and spectrographic-standard Ta. A continuous series of solid solutions is formed between Ta and $\beta$-Ti above 885°C; at 650°C the solid solution is limited to 70 at.% Ti. The solubility of Ta in $\alpha$-Ti is estimated as less than 0.5 at.% at 700°C. The lattice parameters of the $\beta$ solid 3.288 kX for $\beta$-Ti at room temperature. (auth)

1140

THE CREEP/TIME RELATIONSHIP UNDER CONSTANT TENSILE STRESS. S. Bhattacharya, W. K. A. Congreve, and F. C. Thompson. J. Inst. Metals 81, 83-92(1952) Oct.

Work has been carried out at constant stress on Cu, Zn, Sn, Cd, Pb, Al, and the Pb-Sn eutectic. All the results are consistent with the equation $\sigma_t = \sigma_0 + at^k$, where $_t$ and $\sigma_0$ are, respectively, the total and the initial strain, t is the time, and a and k are constants. Creep during the primary stage may also be expressed by a corresponding equation $\sigma_p = a't^{k'}$, where $\sigma_p$ is this primary extension. Once the primary stage is completed, the creep strain $\sigma_c = at^k$, a relationship which is not affected by the space lattice in which the metal crystallizes, temperature, applied stress, nor pre-strain. The results are in accord with the constant-temperature relationship $\sigma = bS^\alpha$, where S is the stress and b and $\alpha$ are constants. Combining the two relationships, it would appear that metals obey the Nutting-Scott Blair equation $\sigma = At^kS^\alpha$, which also describes the flow of many non-metallic substances. If $\sigma_c = at^k$, then the creep rate × time, i.e., $(d\sigma_c/dt)\ t = akt^k$, gives, when plotted against time on a double log scale, a straight line parallel to that obtained for the creep/time relationship itself when similarly plotted. This prediction of the power-law equation is confirmed. The technique is important, in that it obviates the necessity of deriving $\sigma_0$. Since, over the range examined in this work, the use of direct elongation or of natural strain gives curves in close agreement, the creep equation may, if desired, be expressed as: $l_t = l_0 \exp C\ (t/t_0)^k\ (S/S_0)^\alpha$ where $l_0$ and $l_t$ are, respectively, the original length and that after time t, and $t_0$ and $S_0$ are some standard time and stress. Such an equation satisfies all dimensional requirements. (auth)

1141

THE CONSTITUTION OF NICKEL-RICH ALLOYS OF THE NICKEL-TITANIUM-ALUMINIUM SYSTEM. A. Taylor and R. W. Floyd. J. Inst. Metals 81, 25-32(1952) Sept.

The equilibrium relationships of the phases in Ni-rich alloys of the Ni-Ti-Al system over the range 750 to 1150°C have been determined by a combination of micrographic and x-ray-diffraction techniques. At 750°C the f.c.c. solid solution, $\gamma$ holds more than 12 at.% Ti and Al in solution. The $\gamma$ phase is in equilibrium with the intermetallic compound $\eta$-$Ni_3Ti$ and the extensive f.c.c. ordered phase, $\gamma'$, based on $Ni_3Al$. A brief survey of alloys with 50 at.% Ni has revealed a ternary $Ni_2TiAl$ phase $\beta_3$, with a $Cu_2ZnAl$ type of structure, in equilibrium with the $\beta_1$-NiAl and $\beta_2$-NiTi phases, which have CsCl-type structures. In the course of the work the boundaries of the $\gamma$ and $\gamma'$ phase fields in the Ni-Al system have been revised. (auth)

1142

RELATIVE GRAIN TRANSLATIONS IN THE PLASTIC FLOW OF ALUMINIUM. W. A. Rachinger. J. Inst. Metals 81, 33-41(1952) Sept.

The geometry of plastic deformation in the interior of a polycrystalline aggregate has been investigated by means of a grain-counting technique. The respective contributions of grain elongation and relative grain movements to the deformation have been determined for various conditions of temperature and strain rate. At higher temperatures and lower rates of deformation the grains do not elongate in conformity with the aggregate, but tend to remain equiaxed, the external deformation being due to the relative movements of the grains. In addition, the behavior of the surface regions of a polycrystal subjected to high-temperature creep conditions has been studied. The mechanism of plastic flow at the surface is found to be quite different from that in the interior, the transition taking place in a region of only 0.010-in. thickness. (auth)

1143

THE INFLUENCE OF PRIMARY PARTICLES ON THE GRAIN-SIZE OF CAST MAGNESIUM-ALUMINIUM ALLOYS. W. A. Baker, Myriam D. Eborall, and A. Cibula. J. Inst. Metals 81, 43-7(1952) Sept.

Although the superheating and carbon processes for the grain refinement of Mg-Al alloys have now been in use for several years, their modus operandi remains obscure. The work described was directed towards determining whether the processes were basically similar or dissimilar, and whether a nucleating substance was responsible for both, or either, of them. Accordingly, the occurrence of primary particles in alloys of commercial and high purity, and their relation to changes in grain size, brought about in various ways, have been studied. Two types of primary particle were found, one an iron-rich phase, and the other of unknown identity. It is concluded that neither of these types of particle is primarily responsible for grain refinement, but that a nuclear mechanism does operate during both processes. The evidence obtained, although incomplete, is consistent with Al carbide being the grain refiner. (auth)

1144

THE YOUNG'S MODULUS, POISSON'S RATIO, AND RIGIDITY MODULUS OF SOME ALUMINIUM ALLOYS. N. Dudzinski. J. Inst. Metals. 81, 49-55(1952) Sept.

The elastic properties of various binary and ternary Al-base alloys have been examined. With the exception of Ca, Sr, and Mg, all the alloying elements investigated were found to enhance the value of Young's modulus (E) of the binary alloys, Cr having the greatest effect (about $0.47 \times 10^6$ lb/in.$^2$ for 1 wt. %) and Ti, V, Mo, Fe, W, Cu, and Ag having a diminishing influence in the order named. The specific Young's modulus, i.e., the ratio of E to density, of binary alloys was substantially increased by the addition of Mn and Cr. In the ternary systems, Al-Mn-Cr alloys showed the highest increment in E (about $0.5 \times 10^6$ lb/in.$^2$ per 1 wt. % of Mn + Cr); there was no improvement, however, in the presence of Cu or Si. A substantial gain in E was observed in Al-Cu-V and Al-Mn-Ni alloys. The rigidity modulus was found to increase linearly with concentration of the alloying element. (auth)

1145

THE VISCOSITY OF MOLTEN TIN, LEAD, ZINC, ALUMINIUM, AND SOME OF THEIR ALLOYS. T. P. Yao and V. Kondic. J. Inst. Metals. 81, 17-24(1952) Sept.

An oscillating-pendulum method has been used to determine the viscosity of molten Sn, Pb, Zn, and Al as a function of temperature. The binary Sn-Zn and Sn-Pb systems were also investigated, as well as the effect of Ti on the viscosity of Al, and of furnace atmosphere and holding time on the viscosity of Zn. Viscosity values for the pure metals agreed very closely with those generally accepted, except near the freezing point. In this region the viscosity of some metals and alloys proved greater than predicted by the logarithmic law. When plotted against composition, at a constant degree of superheat, the viscosity of Sn-Zn alloys showed maxima in the region of the pure metals and a minimum corresponding to the eutectic. Small additions of Ti appreciably in-

creased the viscosity of Al, and the viscosity of Zn increased with time of exposure to the atmosphere. The viscosities of metals and alloys near the freezing point appear to undergo certain changes that may account for the anomalous behavior of the metals during fluid flow. It is not possible at present to say whether these changes are due to the presence of undissolved phases in the molten metals, or are a result of other factors affecting the liquid state. (auth)

1146

DEFORMATION AND POLYGONIZATION OF ALUMINUM MONOCRYSTALS. Honoré Lambot and Lawrence Vassamillet. Compt. rend. 235, 1232-4(1952) Nov. 17. (In French)

Development of polygonization in Al crystals at deformations up to 10% elongation and under various annealing temperatures was studied with an x-ray-diffraction technique. The effect of impurities on the temperature required for polygonization is noted. (G.Y.)

1147

POLYGONIZATION DURING DIFFUSION. R. W. Balluffi. J. Applied Phys. 23, 1407-8(1952) Dec.

A sandwich-type couple made by pressure welding together $^{3}/_{16}$-in.-thick disks of Cu and Ni was cut in half normal to the welded interface, and one section metallographically polished and then annealed. Considerable evaporation occurred from the Cu side and plastic strain was indicated near the diffusion interface. Extensive subgrain formation was evident on the Ni side. Similar results were obtained by exposing a $^{3}/_{16}$-in. disk of metallographically polished Ni to copper vapor in vacuum at 1060°C. The polygonization is explained on the basis of plastic strain introduced by dimensional changes normal to the diffusion direction. (L.M.T.)

1148

FORMING AND WELDING OF TITANIUM. Francis H. Stevenson. Welding J. (N.Y.) 31, 1035-41(1952) Nov.

Stretch-forming tests on Ti were made at ambient temperature with and without interstage annealing and at elevated temperature with and without interstage annealing. Spot welding and fusion welding of Ti-75A indicate that, in general, the same forming techniques as used for 300 stainless steel may be used, with the exception that the parts or dies should be heated to 600 to 1000°F. The same techniques as used in the spot welding of 347 stainless steel may be used to spot-weld Ti. Fusion welds can be made using standard, inert-gas-shield arc-welding equipment. It is necessary that the weld be shielded carefully until it cools to 400°F. (L.T.W.)

# PHYSICS

1149

New York Univ.

PROGRESS REPORT 6 ON FLUORESCENCE AND CONDUCTIVITY PHENOMENA, by Hartmut Kallmann. Oct. 1952. 68p. (NP-4292; Progress Report 6)

Fluorescence of organic molecules, investigation of light emission as a function of time, and investigation of storage phosphors are described. Studies on fluorescence of organic molecules include structural effects on fluorescence, fluorescence of solutions with more than one solute, and absolute light-emission efficiency of anthracene crystals. Studies on storage phosphors include detection of weak doses, stimulated intensity as function of dose, and storage decay. (L.T.W.)

1150

Columbia Univ.

INTERFACIAL THERMAL AND ELECTRICAL RESISTANCE BETWEEN STATIONARY MERCURY AND STEEL, by Charles F. Bonilla and S. J. Wang. Dec. 1, 1952. 19p. (NYO-3091)

The interfacial thermal and electrical resistance between liquid Hg and horizontal low-C steel plates were measured simultaneously as a function of pressure, temp., and dissolved Na and Mg contents. Moderately reproducible results could be obtained. Pressure, and current direction and density, had no appreciable effect on either resistance. Raising the temp. decreased the electrical resistance in a partially reversible way. Adding Mg or Na to the Hg gave better wetting and correspondingly larger angles, and decreasing electrical contact resistance in the order named. The thermal resistance is, in general, more constant than the electrical resistance. The Wiedmann-Franz ratios were computed for each plate in each test, and were consistently smaller the higher the temp. They averaged from 2 to over 100 times the theoretical value for metals. It seems likely that heat transfer across an interface is primarily caused by the electrons. However, more work is required before definite conclusions can be drawn or applications made. (auth)

1151

Oak Ridge Inst. of Nuclear Studies

QUARTERLY PROGRESS REPORT FOR JULY 1–SEPTEMBER 30, 1952. [nd] 56p. (ORO-83)

Administrative and educational programs are summarized. Investigations of a 70-day activity produced by the irradiation of Ti with thermal neutrons, the Th content of ocean water, the Th content of U ores, and the chemistry of Po, using ion exchange methods, are reported to be in progress. Construction is reported of vacuum-tube electrometers, which compare favorably in performance with vibrating-reed electrometers, and can be easily assembled from readily available parts at a cost of about $140 each. Design of a simple, high-resistance selector switch for use with the electrometers is also reported. The use of Victoreen thimble chambers for measurement of $\gamma$ dosage to experimental animals is being investigated. Measurements made to determine the effective curie strength of a $Co^{60}$ teletherapy source are reported. Data are presented on the fate and distribution of colloidal $Au^{98}$ injected into serous cavities of 30 patients with effusions caused by malignant neoplasm. Autopsy findings are included for 12 patients with advanced malignancy who were treated with colloidal $Au^{198}$ for relief of effusion. (C.R.)

1152

HEAT EXCHANGE BETWEEN A SOLID AND He II. I. M. Khalatnikov. Zhur. Eksptl'. i Teoret. Fiz. 22, 687-704 (1952) June. (In Russian)

Possible mechanisms governing heat exchange between a solid and He II are discussed. It is shown that the basic mechanism consists in radiation (and absorption) of energy by the boundary of the solid undergoing thermal oscillations. The energy flow on the boundary between the solid and He II is proportional to the difference of the fourth powers of the temperatures of these bodies. The coefficient of transmission of second sound through a thin heat-conducting plate is computed.

1153

ISOTHERMAL ORDERING OF $Cu_3Au$ at 200°C. E. K. Halteman, G. F. Mechlin, and H. L. Glick. Phys. Rev. 88, 1205(1952) Dec. 1.

The effect of heat treatment on the isothermal transformation rate of $Cu_3Au$ alloy has been investigated. In one case a disordered sample was prepared by heating an ordered $Cu_3Au$ wire for 4 hrs at 400°C and quenching to room temp. at a rate of 15°C/min. A second sample was heated for 16 hrs at 800°C, then quenched in iced brine at −10°C.

The samples were then heated to ~200°C and resistance measurements made as a function of time. From a comparison of the data obtained without radiation to those of Blewitt and Coltman (Phys. Rev. 85, 684(1952)) obtained at 200°C with pile radiation, it appears that it may be possible by heat treatment alone to closely duplicate the time dependence of resistance of $Cu_3Au$ observed in the Oak Ridge reactor. (L.M.T.)

*AEROSOLS*

1154

Oak Ridge National Lab., Y-12 Area

THEORY OF A DIFFUSION BATTERY, by Wendell DeMarcus and Jess W. Thomas. Oct. 16, 1952. 28p. (ORNL-1413)

A diffusion battery consists of a number of long, narrow, rectangular channels arranged in parallel, through which an aerosol moves in streamline flow. The object of the work described in this report was to develop an equation relating the fractional penetration of the aerosol with the diffusion constant of the aerosol. An equation has been developed which allows the calculation of the diffusion constant from known operating parameters in the case of negligible settling due to gravity, and a second equation developed to permit calculation of the settling velocity in case of particle removal due to both diffusion and gravity. A method for calculating the particle size and mass from the diffusion constant and settling velocity is given. (auth)

*COSMIC RADIATION*

1155

SPATIAL DISTRIBUTION OF PENETRATING PARTICLES IN ATMOSPHERIC SHOWERS OF COSMIC RAYS. L. Kh. Eĭdus, M. I. Adamovich, I. A. Ivanovskaya, V. S. Nikolaev, and M. S. Tulyankina. Zhur. Eksptl'. i Teoret. Fiz. 22, 440-7(1952) Apr. (In Russian)

The spatial distribution of penetrating particles in atmospheric showers has been investigated by means of counters connected to hodoscopes. It is shown that the per cent of penetrating particles increases proportionally to the distance to the shower's axis. The total energy of penetrating particles exceeds half the total energy of the shower. Proofs of existence of showers with a complex spatial structure are presented.

1156

SEASONAL VARIATION OF LARGE COSMIC-RAY BURSTS. T. Kameda and M. Wada. Progress Theoret. Phys. (Japan) 7, 586-8(1952) May-June.

A marked seasonal variation in the burst frequencies of cosmic rays at sea level and at basement were found in a recent experiment (Kameda, Progress Theoret. Phys. (Japan)) 7, 1(1952)). The data are plotted in the following manner: (1) burst frequencies vs. month for Tokyo (sea level), Cheltenham, and Tokyo (basement), and (2) burst frequencies vs. atmospheric temp. at the same locations. (L.M.T.)

1157

A STATISTICAL STUDY OF THE DISTRIBUTION OF STARS IN NUCLEAR EMULSIONS. F. B. Brown, Jr. and A. V. Masket. Phys. Rev. 88, 1204-5(1952) Dec. 1.

A statistical study, with particular emphasis on close grouping, is reported on 1723 stars (from 3 to 40 prongs) found on 11 Ilford G-5 nuclear plates exposed at 84,000 ft for 6½ hrs. The number of close pairs observed was much greater than anticipated from a theoretical distribution plot. To determine the types of stars causing the nonrandom double-star formations, the distribution of minimal distances was re-evaluated considering only stars of 3, 4, and 5 prongs, disregarding the larger stars. This resulted in a curve of 901 smaller stars which fits the theoretical distribution. It was found that the distribution among large stars only was nonrandom and several possible explanations are advanced for this. (L.M.T.)

1158

ANGULAR DISTRIBUTION FUNCTIONS FOR HIGH ENERGY COSMIC-RAY PARTICLES. H. S. Green, H. Messel, and B. A. Chartres. Phys. Rev. 88, 1277-83(1952) Dec. 15.

The main purpose of this paper is to provide theoretical data which should enable one (a) to distinguish between two different types of differential cross sections for nuclear collisions at high energies, equally compatible with present experimental indications, and (b) to differentiate between certain models of meson production. The exact angular-distribution function is determined on the basis of one type of differential cross section, for both mesons and nucleons, in high-energy nucleon-nucleus collisions, and in any type of medium. For both types of cross section, formulas are derived for the general moment of the angular distribution. Numerical results for the mean-square angle of scattering of mesons and nucleons in collisions between a nucleon and a nucleus are presented graphically for both light and heavy nuclei. 12 references. (auth)

*ELECTRICAL DISCHARGE*

1159

LONGITUDINAL WAVES IN AN IONIZED MEDIUM (PLASMA). M. E. Gertsenshtein. Zhur. Eksptl'. i Teoret. Fiz. 22, 303-9(1952) Mar. (In Russian)

The dielectric permeability of electron plasma is computed taking into account the electron motion, which is found to depend on the spatial structure of the field. The concept of spatial dispersion is introduced. Properties of longitudinal waves and their connection with transverse waves are investigated.

1160

PECULIARITIES OF FLUCTUATIONS IN THE NUMBER OF PARTICLES IN A SYSTEM WITH COULOMB INTERACTION. I. Z. Fisher. Zhur. Eksptl'. i Teoret. Fiz. 22, 520-3(1952) May. (In Russian)

The author evaluates fluctuations in the number of particles. In a not-too-small volume the fluctuations in the number of particles differ essentially from that in an ideal gas, independently of the degree of rarefaction.

1161

INFLUENCE OF THERMAL IONIZATION ON THE DISTRIBUTION OF PARTICLES IN A NONUNIFORMLY HEATED GAS. A. A. Abrikosov. Zhur. Eksptl'. i Teoret. Fiz. 22, 320-30(1952) Mar. (In Russian)

Thermodiffusion in thermally ionized gases is analyzed. It is found that, owing to diffusion of ions of various charge, the coefficient of thermodiffusion may change sign and reach even high values.

1162

PARTICLE DISTRIBUTION IN A NONUNIFORMLY HEATED, FULLY IONIZED GAS. A. A. Abrikosov. Zhur. Eksptl'. i Teoret. Fiz. 22, 310-20(1952) Mar. (In Russian)

Thermodiffusion in fully ionized gases is analyzed. The coefficient of thermodiffusion is computed for two boundary cases in the second approximation and in a general case in the first approximation.

*ELECTRONS*

1163

DISCUSSION: MODELING THE MOTION OF CHARGED PARTICLES IN AXIAL-SYMMETRICAL MAGNETIC FIELDS. D. L. Kaminskiĭ and V. M. Kel'man. Zhur. Tekh. Fiz. 22, 703-6(1952) Apr. (In Russian)

The authors criticize an article by Tsukkerman (Zhur. Tekh. Fiz. 21, 599(1951)) which stated that an axial-symmetrical magnetic field scatters electrons similarly to an opti-

cal lens. Although it may occur in very particular cases, the authors consider it impossible to construct a magnetic scattering lens.

*GASES*

1164

A RELATION AMONG THE KINETIC THEORY CROSS-SECTION INTEGRALS AND NEW RELATIONS INVOLVING THE TRANSPORT PROPERTIES OF GASES. Eugene M. Holleran and Hugh M. Hulburt. J. Phys. Chem. 56, 1034-8(1952) Dec.

A recurrence relation among the kinetic theory cross-section integrals is derived for spherically symmetrical intermolecular potentials. Its use as a check on previous calculations of the integrals is illustrated. It is also used to derive new relations between the integrals and the transport properties of gases. These equations are shown to be very exacting tests for the correspondence between a postulated molecular model and experimental measurements. Predictions of the Lennard-Jones 13,7 potential are compared with experimental data for argon by means of one of these equations. Finally, the recurrence formula is used to derive new relations among the transport properties themselves. The sign of the thermal diffusion ratio, $R_T$, is shown to depend simply on the magnitude of the slope of ln D vs. ln T. The thermal diffusion ratio for isotopic mixtures is found as a function of the coefficients of viscosity and diffusion of either pure isotope. Values of $R_T$ for argon calculated from this equation agree well with experimental data. A simple relation between diffusion and thermal diffusion for Lorentzian mixtures is shown to be a good approximation for other mixtures near the inversion temperatures. (auth)

*INSTRUMENTS*

1165

David Sarnoff Research Center

QUARTERLY REPORT NO. 9 [ON] ELECTRONIC DEVICES FOR NUCLEAR PHYSICS [FOR] JULY, 1952 - OCTOBER, 1952. Nov. 25, 1952. 21p. (AECU-2327; Quarterly Report No. 9)

Progress is reported on Types H-5037 and 4646 photomultipliers, the automatic distribution-width measuring instrument, and the AEC pulse-amplitude analyzer. Secondary emission time delay characteristics of photomultiplier tube H-5172 have been investigated. Additional observations have been made on after-pulsing, secondary emission, and loss of photosensitivity in photomultipliers. (L.M.T.)

1166

Carbide and Carbon Chemicals Co. (K-25)

VIBRATION EFFECTS ON THE TAYLOR 206R PRESSURE TRANSMITTER, PART I, by A. H. Fowler and G. H. Job. Issued Sept. 3, 1952. 18p. (K-973)

This report describes a study of the mechanical vibration response of the Taylor 206R Pressure Transmitter. The methods employed to determine the causes of vibratory disturbances and the corrective measures attempted are discussed and recommendations for the reduction of this vibration response are described. The best corrective method found was to install a dashpot on the sensing lever and to remove the capillary tubing in the secondary bellows assembly. A number of transmitters so altered will be installed in the process area to determine their performance under field conditions. These observations and the results of further study of the problem will be included in Part II of this study. (auth)

1167

Mound Lab.

INSTRUMENTATION AND TECHNIQUES RESEARCH QUARTERLY PROGRESS THROUGH DECEMBER 17, 1952, by J. W. Heyd. Dec. 31, 1952. 6p. (MLM-792)

Progress is briefly reported on polarography, calorimetry, quartz-fiber microbalance, and special instrumentation. Radiation measurement studies include techniques for preparing very thin conducting absorbers, development of a counting system of constant resolving time, detecting low-energy $\alpha$ particles in high $\gamma$ background, and development of a scintillation-type, continuous air monitor. (L.M.T.)

1168

Livermore Research Lab., Calif. Research and Development Co.

FIRING TIME OF IGNITRONS, by W. Estkowski. Nov. 4, 1952. 14p. (MTA-3)

Selection of the proper grid voltage and grid current for firing a GL-5630 ignitron makes it possible to drop a 10,000-v plate voltage to zero in 0.16 $\mu$sec from the beginning of grid-voltage application. The plate current increases from zero to 400 amp in 0.21 $\mu$sec from the start of the pulse. (auth)

1169

Carnegie Inst. of Tech.

A CRITICAL COMPARISON OF BASIC METHODS OF ANALYSIS OF MAGNETIC AMPLIFIERS; MAGNETIC AMPLIFIERS–TECHNICAL REPORT NO. 11, by L. A. Finzi and G. F. Pittman, Jr. Aug. 1952. 32p. (NP-4234; Technical Report No. 11)

This report results from a survey of many technical papers on magnetic amplifiers and attempts to clarify the apparent diversities of terminology and interpretation of results and to classify them into a small number of groups characterized by common features. (L.M.T.)

1170

Oak Ridge National Lab.

INSTRUMENT RESEARCH AND DEVELOPMENT QUARTERLY PROGRESS REPORT FOR PERIOD ENDING OCTOBER 20, 1952. Issued Jan. 2, 1953. 10p. (ORNL-1436)

Progress is briefly reported on the following: a low-drift d-c amplifier, a derivative polarograph, a portable integrating-type personnel radiation monitor, automatic titrator, reversing-cycle power supply, liquid-level indicator, neutron-sensitive thermometer, tube tester and ager, h-v power supply, and multichannel analyzer. (L.T.W.)

1171

THE PROCESSING OF NUCLEAR EMULSIONS UP TO 200 MICRONS. K. R. Dixit. J. Sci. Ind. Research (India) 11, 351-5(1952) Sept.

A method for processing Ilford nuclear emulsions C2 and G5, 200 $\mu$ and 100 $\mu$ thick, is described. The process consists in initiating development at a low temperature (<5°C) and allowing it to go to completion at a higher temperature (<20°C), checking development in acetic acid stop bath and fixing, without agitation, first in hypo with hardener and then in hypo without hardener. Two photomicrographs are given to illustrate the clarity of the plates; one of them is a rare event showing a negative $\pi$ meson produced in a fission, producing another fission. (auth)

1172

BACKGROUND IN AMPLIFIERS FOR PULSE-TYPE IONIZATION CHAMBERS. G. Valladas and A. Lévêque. J. phys. radium 13, 521-6(1952) Nov. (In French)

The precision in measurements of charges liberated in pulse-type ionization chambers is limited by the inherent background in the amplifier. The authors review briefly first the principal characteristics of the signal received at the collecting electrode and of the background, then the theory of Milatz and Keller (Physica 9, 97(1942)). This theory established the existence of an absolute limit to the precision of measurements, characteristic of the preampli-

fying tube, and permitted its calculation. The transitory response of an ideal amplifier allowing this precision to be obtained is defined, and a practical circuit having this response is proposed. When the method of Scherr and Peterson (Rev. Sci. Instruments 18, 567(1947)) is used, the preceding theory is not satisfactory. The optimum transitory response and limiting precision are calculated for this case, and several simple circuits are compared as to precision limits. (tr-auth)

*ISOTOPES*

1173

VARIATIONS IN THE RELATIVE ABUNDANCES OF THE ISOTOPES OF COMMON LEAD. C. B. Collins, R. M. Farquhar, and R. D. Russel. Phys. Rev. 88, 1275-6(1952) Dec. 15.

Mass-spectrometer measurements of the relative isotopic abundances of samples of lead ores from Archean-type rocks showed larger variations than reported by Nier. From the new measurements combined with existing data estimates of the time of formation of the earth's crust of 3.5 billion years and of a maximum time of formation of the elements of 5.5 billion years have been calculated. These values are in reasonable agreement with previous estimates. (auth)

*MASS SPECTROGRAPHY*

1174

Oak Ridge National Lab.

MASS SPECTROMETER STUDY OF SILICON TETRAFLUORIDE, by Robert E. Rummel, John R. Sites, and Russell Baldock. Oct. 10, 1952. 9p. (ORNL-1406)

$SiF_4$ was analyzed in a sector-type mass spectrometer, and the cracking pattern was determined along with appearance potential curves. Also, $UF_4$ was investigated at high temperature and an intense $SiF_4$ pattern with several metastable masses was found. (auth)

1175

FOCUSING PROPERTIES OF A COMBINATION OF A MAGNETIC FIELD DECREASING WITH RADIUS AND A CYLINDRICAL ELECTRIC FIELD. Dietert Fischer. Z. Physik 133, 455-70(1952). (In German)

From the equations of motion of charged particles in an arbitrary combination of a cylindrical electric field and an inhomogeneous magnetic field decreasing with radius, focusing properties, especially the focusing angle and mass and velocity dispersions, were derived and were compared with the values calculated by Henneberg (Ann. Physik 19, 335 (1934)) and Herzog (Z. Physik 89, 447(1934)) for the same combination with a homogeneous magnetic field. The mass-resolving power under the various conditions was investigated with regard to application in mass spectrometry. It was found that the investigated combination in every case gave double-directional focusing (radial and axial) and that mass and velocity dispersion, as well as resolving power, for energy-homogeneous particles was twice as great for the decreasing magnetic field as for the homogeneous field. That combination with decreasing field in which velocity focusing, in addition to directional focusing, appears is superior in principle to every other combination with respect to resolving power and intensity. (tr-auth)

1176

SECOND-ORDER FOCUSING BY SECTORIAL MAGNETIC FIELDS. J. Geerk and C. Heinz. Z. Physik 133, 513-23 (1952). (In German)

A focusing theory in the second approximation is formulated for homogeneous, rectilinear sectorial magnetic fields. The second-order focusing has advantages in that the aperture error is reduced and intensity is gained by increasing the aperture angle. Starting point of the investigation was the caustic curve, the geometric locus for first-order focusing. Conditional equations for a caustic inversion point are presented, and it is shown that such a point is exhibited by appropriate trajectories in an ion-optical system for second-order focusing. Introduction of angular spread as a parameter gives the conditional equations a relatively simple form. A method for calculating the second-order image curve is devised. (tr-auth)

1177

A MASS SPECTROMETER WITH DOUBLE DIRECTIONAL AND VELOCITY FOCUSING. Dietert Fischer. Z. Physik 133, 471-84(1952). (In German)

A mass spectrometer in which a cylindrical electric field is superimposed on a magnetic field decreasing with radius is described. The spectrometer possesses radial and axial, as well as velocity, focusing. Focusing properties, resolving power, and intensity ratios were determined, using an ion source of the type of Goldmann's "proton gun." The deflection chamber was so constructed that the spectrometer could be operated with an arbitrary combination of homogeneous or decreasing magnetic field with or without a cylindrical electric field. The various focusing angles under these conditions were found from attachments to the chamber. (tr-auth)

*MATHEMATICS*

1178

Argonne National Lab.

SOLID ANGLE SUBTENDED BY A CIRCULAR APERTURE AT POINT AND SPREAD SOURCES: FORMULAE AND SOME TABLES, by Arthur H. Jaffey. Sept. 1952. 29p. (ANL-4875; UAC-638)

A survey is made of formulas for the calculation of the solid angle subtended by a circular aperture at an isotropically emitting point or spread source. Some of the formulas are new and of particular convenience for calculation. Two tables of solid angle values are included. (auth)

1179

SOME PROPERTIES OF THE RACAH AND ASSOCIATED COEFFICIENTS. L. C. Biedenharn, J. M. Blatt, and M. E. Rose. Revs. Modern Phys. 24, 249-57(1952) Oct.

Properties of the Racah and the related "Z" coefficients are discussed, and algebraic formulas for them are tabulated. References are given to specific applications in scattering problems, nuclear structure, and atomic and molecular spectra. (G.Y.)

1180

OPERATOR CALCULUS OF QUANTIZED OPERATOR. Izuru Fujiwara. Progress Theoret. Phys. (Japan) 7, 433-48(1952) May.

The notational ambiguities in Feynman's calculus are all remedied here by setting a more natural foundation of the ordered exponential operators, which will be called briefly "expansional" operators in this paper. The essential point to be stressed is that the pure exponential operator is merely a special case of the more wider class of operators, i.e., expansional operators, and the latter type of operators generally appears in quantum mechanics. A clear-cut distinction between these two types of operators is all important. The so-called disentangling process is a device to decompose any one expansional operator into a product of some simple exponential operators. In the first place the general viewpoints concerning the expansional operators are presented, in which a rigorous organization of disentangling procedure is accomplished. Next are given some examples treating a generalized forced harmonic oscillator, where the transformation operator is completely disentangled and its representative yields automatically the classical action in its compact form, which process constitutes the original

intention of this work. No accounts are given here concerning the quantized field theory. (auth)

*MEASURING INSTRUMENTS AND TECHNIQUES*

1181

Brookhaven National Lab.

A RADIATION MONITOR FOR MEASURING $A^{41}$ BETA RADIATION DOSAGE AT BROOKHAVEN NATIONAL LABORATORY, by Aaron P. Sanders. [nd] 32p. (BNL-1304)

The construction, calibration, and use of a sensitive detection instrument to determine the dosage component of the $A^{41}$ in the cooling-air effluent of the Brookhaven reactor are described. An instrument capable of detecting radiation levels of ~10 rep/hr was required. The existing $\gamma$-sensitive dynamic-condenser electrometer (Kuper and Chase, Rev. Sci. Instruments 21, 356-7(1950) Apr.) was made $\beta$-sensitive by two modifications. The $\frac{1}{8}$-in. bakelite wall was replaced by a thin wall, and the position of the ionization chamber was changed to improve the geometry of the instrument. (L.T.W.)

1182

Radiation Physics Lab., National Bureau of Standards

CALIBRATION OF TYPE-APPROVAL UNITS OF THE AN/PDR-32 RADIAC SETS, by F. H. Day and T. P. Loftus. Oct. 15, 1952. 14p. (NBS-2033)

The calibration of 5 type-approval units of the AN/PDR-32 radiac sets is described. The first unit was calibrated with $Co^{60}$ $\gamma$ rays and x rays of 150 and 80 kev energies, the others with only the $Co^{60}$ source. A comparison of the various instrument readings for given applied dosage rates is given in the data. Data also include the directional-dependence testing of the first unit over the 30 to 330° range. (L.M.T.)

1183

Syracuse Univ.

FIRST QUARTERLY PROGRESS REPORT [ON] NON-ELECTRONIC DOSE RATE INDICATING SYSTEMS [FOR] JUNE 15–SEPTEMBER 15, 1952, by Myron G. Berry and Henry Linschitz. [nd] 36p. (NP-4207)

An extensive literature survey is being made. A bibliography is presented summarizing the work to date, and giving references to papers describing effects which may possibly be suitable for dose-rate measurement. A discussion of the current results of the literature survey is given, including the various categories of phenomena which seem most promising, and specific references to the most relevant papers in the bibliography. (auth)

1184

PRECISION MEASUREMENTS OF NUCLEAR GAMMA-RADIATION BY TECHNIQUES OF BETA-SPECTROSCOPY. PART I. THE SPECTROMETER WITH TWO-DIRECTIONAL FOCUSING AS A TOOL FOR PRECISE GAMMA-MEASUREMENTS. Arne Hedgran. Arkiv Fysik 5, 1-27(1952)

A brief review is given of the crystal-diffraction and beta-spectrometer methods employed in $\gamma$ spectroscopy. The remainder of the report is then concerned with the application to the problem of a two-directional-focusing $\beta$ spectrometer described by Hedgran (Proc. Phys. Soc. 63, 960(1950)). The focusing properties of the instrument and the source arrangement mechanism are dealt with at length. The theory, design and construction, and electrical arrangement of the field-measuring system are discussed. Treatment is given the various factors affecting the accuracy of the instrument. 26 references. (L.M.T.)

1185

PRECISION MEASUREMENTS OF NUCLEAR GAMMA-RADIATION BY TECHNIQUES OF BETA-SPECTROSCOPY. PART II. DETERMINATION OF CALIBRATION ENERGY STANDARDS USING GOLD$^{198}$, ANNIHILATION RADIATION AND COBALT$^{60}$. David Lind and Arne Hedgran. Arkiv. Fysik. 5, 29-52(1952)

In the course of determining calibration energy standards for the two-directional-focusing $\beta$ spectrometer using the $Au^{198}$ $\gamma$ ray (411 kev) and annihilation radiation (511 kev), an apparent discrepancy resulted. Interest is concentrated on the annihilation radiation, the $Au^{198}$ $\gamma$ ray energy being assumed as the best standard. The experiments indicate that the inconsistency is real. The comparison is performed by the external conversion method, employing U as the external converter. Since the difference between K and $L_{III}$ binding energies of the U atom is ~98 kev, the K photoelectron line from annihilation radiation should be separated from the $L_{III}$ photoelectron line by only about 1 part in 1000 on the momentum scale. Data are also given of a comparison between the same $Au^{198}$ $\gamma$ ray and the 1.33-Mev $Co^{60}$ $\gamma$ ray using the external converter method with U as the external converter. 26 references. (L.M.T.)

1186

COUNTER TUBES WITH METHYLENE HALIDES AS VAPOR ADDITIVE. H. Neuert and H. Gutbier. Z. Physik 133, 451-4(1952). (In German)

Mass-spectrographic investigation of the composition of gases in $CH_2Cl_2$- or $CH_2Br_2$-filled counter tubes showed that the life of such counters is limited primarily by the formation of HCl or HBr from the vapor. Lives of ~$10^9$ counts were obtained for tubes operated in the quenching region. (tr-auth)

1187

RELATION BETWEEN THE SENSITIVITY OF A PHOTOGRAPHIC LAYER TO SHORT-DURATION ILLUMINATION AND ITS SENSITIVITY TO ELECTRONS. A. L. Kartuzhanskiĭ. Zhur. Eksptl'. i Teoret. Fiz. 22, 768-74(1952) June. (In Russian)

The sensitivities of a number of photographic layers to electrons and to intense illumination of short duration are compared. Parallelism of these two properties is confirmed, in full agreement with theoretical concepts.

1188

NUCLEAR EMULSION TECHNIQUE. Arthur Beiser. Revs. Modern Phys. 24, 273-311(1952) Oct.

Properties of nuclear emulsions, track production and evaluation, emulsion processing, and auxiliary techniques are reviewed extensively. (G.Y.)

1189

A STATISTICAL ANALYSIS OF GRAIN COUNTING IN PHOTOGRAPHIC EMULSIONS. W. W. Happ, T. E. Hull, and A. H. Morrish. Can. J. Phys. 30, 699-714(1952) Nov.

Fluctuations in the grain density of tracks of charged particles passing through photographic emulsions are examined in terms of the physical properties of grains and the type of counting convention used. A mathematical model, for one counting convention which takes into account both the frequency distribution of the grains and the frequency distribution of their lengths, yields numerical results in good agreement with experimental data. Other statistical problems of interest in grain counting are discussed. (auth)

1190

SCINTILLATION COUNTERS FOR X-RAYS. Gösta Brogren, and Carl-Gösta Rylander. Arkiv Fysik 4, 495-9(1952)

Results of efficiency tests with napthalene, Ag-activated ZnS, $CdWO_4$, and Tl-activated NaI crystals for use in scintillation counters for x-ray detection are reported. (L.M.T.)

1191

COMPONENTS OF IONIZATION CURRENT PRODUCED BY GAMMA RAYS. I. V. Estulin. Zhur. Eksptl'. i Teoret. Fiz. 22, 414-20(1952) Apr. (In Russian)

The ionization current produced by $\gamma$ rays in a flat slit chamber used for measuring the equilibrial intensity of

electrons in various materials is separated into three components: I and $I_2$ produced by electrons generated in the chamber walls and $I_{12}$ produced by mutual effect of the chamber walls (effect of electron "reflection"). Experiments were performed in chambers of Pb, Sn, Cu, Fe, Al, and C with $\gamma$ radiation from Ra and RdTh.

1192

A NUCLEAR SPECTROMETER FOR HEAVY PARTICLES. PART I. DESIGN AND CONSTRUCTION OF THE INSTRUMENT. Curt Mileikowsky. Arkiv Fysik 4, 337-46(1952).

The purpose and theory of the heavy-particle nuclear spectrometer are briefly discussed. Design features and auxiliaries which are described include the analyzing-magnet yoke and pole pieces, the magnet coils (for electric current and cooling $H_2O$), the rotatable foot plate, the motor-generator equipment, the regulating and stabilizing device, and the vacuum chamber. (L.M.T.)

1193

FADING EFFECT IN NUCLEAR-TRACK PLATES. W. Hälg and L. Jenny. Helv. Phys. Acta 25, 773-4(1952) Dec. 15. (In German)

Normal latent-image fading in air at 20°C and 50 to 55% relative humidity, and accelerated fading in air at 90% relative humidity or over 3% $H_2O_2$ solution, has been studied in Ilford C2 emulsion exposed to 3- or 6-Mev protons and in an unstabilized AgBr emulsion exposed to 3-Mev protons or 5.3-Mev $\alpha$ particles. Ratios of long-lived to short-lived components (cf. NSA 6-838) and the effect of stabilization of the emulsion on these ratios are considered. (G.Y.)

1194

ON THE DESIGN OF A 15 MEV $\beta$-RAY SPECTROMETER. R. L. Graham and O. Klemperer. Proc. Phys. Soc. (London), 65B, 921-34(1952) Dec.

The design of a lens spectrometer with respect to economy in power consumption and copper weight, resolving and collecting power has been studied by small-scale experiments. The construction and performance of a large $\beta$-ray spectrometer is described which focuses 15-Mev electrons when its coil is energized by 50 amp at 360-v. The coil is cooled by a flow of 12 gal of water per minute. Maximum resolution and collecting power of the spectrometer are 0.8% and 0.6%, respectively. The influence of spherical aberration, source, and window size on the resolution of the thick-lens spectrometer are discussed. 13 references. (auth)

1195

SOME ABSOLUTE DETERMINATIONS OF PROTON-GAMMA RESONANCES IN THE ENERGY RANGE BELOW 500 KEV. S. E. Hunt. Proc. Phys. Soc. (London) A65, 982-9(1952) Dec.

An electrostatic analyzer of high accuracy has been used to measure and control the energy of a proton beam accelerated by an electrostatic generator. By using a deflecting angle of $\pi/2\sqrt{2}$ radians, a wide incident beam was focused on to a narrow exit slit. Target currents of 10 $\mu$a were obtained homogeneous in energy to one part in a thousand. The beam energies were also measured absolutely to this accuracy. The instrument was used to determine the energy of the $Li^7(p,\gamma)$ resonance, which was found to be 441.5 ± 0.5 kev with a half width of 12.2 ± 0.5 kev. The energies of two sharp resonances in fluorine were found to be 340.4 ± 0.4 and 483.1 ± 0.5 kev, with half widths 2.9 ± 0.2 kev and 2.2 ± 0.2 kev, respectively. 16 references. (auth)

1196

PRECISION COUNTING OF ALPHA PARTICLES WITH SPECIAL REFERENCE TO THE DETERMINATION OF STANDARD SOURCES. R. Hurst and G. R. Hall. Analyst 77, 790-800(1952) Nov.

Methods of $\alpha$-particle counting are discussed, and special reference is made to the absolute determination of standard sources by the use of $\alpha$ proportional counters of known low geometry. Operating details of one such counter are discussed. (auth)

1197

ABSORPTION COEFFICIENTS OF $\beta$ ENERGY OF RADIOACTIVE ISOTOPES IN AIR-EQUIVALENT SUBSTANCES. K. Sommermeyer. Naturwissenschaften 39, 506-7(1952) Nov. (In German)

An expression for the absorption coefficient of $\beta$ particles in air-equivalent substances in terms of their energies is given. Approximation to a purely exponential absorption law and agreement with measured coefficients are discussed. (G.Y.)

*MESONS*

1198

THE CAPTURE PROCESS OF $\pi$ MESONS BY DEUTERONS. Yoshiro Matsuzaki and Muneo Sasaki. Progress Theoret. Phys. (Japan) 7, 573-7(1952) June.

The capture of positive $\pi$ mesons by deuterons is theoretically treated under the assumption that mesons are of pseudoscalar type and have pseudovector coupling. The authors have also taken into consideration the forces in the final triplet P state of the p-p system and investigated their influence on the final results. The calculation shows that if one assumes strong repulsion in the P state, better agreement with experiments is to be obtained. (auth)

1199

BIRTH OF SLOW MESONS IN THE GLASS OF PHOTOPLATES. Zh. S. Takibaev and B. K. Kazieva. Zhur. Eksptl'. i Teoret. Fiz. 22, 783-4(1952) June. (In Russian)

The author describes his experimental work with cosmic rays on Mount Pamir (4700 m). He concludes that additional mesons are produced within the glass of photoplates; therefore in his research he now uses photoemulsions without glass background.

1200

MULTIPLE MESON PRODUCTION IN NUCLEON-NUCLEON COLLISIONS. H. W. Lewis. Rev. Modern Phys. 24, 241-8 (1952) Oct.

The varied theoretical work on multiple production of mesons in a single nucleon-nucleon collision is surveyed, and a classification based on content and concept is attempted. A distinction is made between "fundamental" work, the derivation from equations of nucleon and meson motion of the probability of meson emission, and "kinematic" work, the prediction of observed properties of observed events. The fundamental treatments are divided into "preexisting field" and "excited field" types. The preexisting field treatments suppose that the characteristics of the radiated meson field are primarily determined by the interaction of the field with the free nucleons before the collision. The excited field treatments minimize this mechanism and suppose that the collision has the primary effect of transferring a great deal of energy and momentum into the volume immediately surrounding the point of collision and that the character of the subsequent radiation is largely determined by the strong fields and interaction in the "hot spot." The role of the potential is considered separately. (G.Y.)

1201

MULTIPLE COULOMB SCATTERING OF HIGH ENERGY PIONS IN PHOTOGRAPHIC EMULSIONS. Meera Backus, J. J. Lord, and Marcel Schein. Phys. Rev. 88, 1431-2(1952) Dec. 15.

Negative pions of 226 ± 7 Mev were allowed to pass through two 200-$\mu$ Ilford G5 plates nearly parallel to the plate surfaces. The lateral displacement of the tracks was measured at equal distances (cell lengths) and the set of second differences of these lateral displacements provides a measure of the multiple scattering of the pions. Of the 89 tracks measured, the average length was 8000 $\mu$, only 10%

were shorter than 5600 μ, and no measured length of track shorter than 3500 μ was found. A histogram of the frequency distribution of second differences is given for cell lengths of 250 μ. A plot of the variation of the absolute value of the second difference with cell lengths shows the variation to be slightly less than that predicted from theory. (L.M.T.)

1202

THE COUPLING CONSTANT OF THE NUCLEON-μ-MESON INTERACTION. M. A. Preston and M. F. Duret. Phys. Rev. 88, 1425(1952) Dec. 15.

In this note attempt is made to find a more reliable value for the coupling constant $G_\mu$ of the nucleon-μ-meson interaction based on the μ-meson capture rate of $C^{12}$. Calculations are made in terms of 3 nuclear models, a gaussian, the Chew-Goldberger-Temmer, and the shell. The value determined as most likely for $G_\mu$ is $\sim 3.2 \times 10^{-49}$ erg/cm³. (L.M.T.)

1203

LIFETIMES OF THE $\mu^-$-MESON STOPPED IN Li, Be, AND C. W. E. Bell and E. P. Hincks. Phys. Rev. 88, 1424-5 (1952) Dec. 15.

Lifetimes of $\mu^-$ mesons stopped in Li, Be, and C have been determined with the apparatus used for measurement of the $\mu^+$-meson lifetime (Phys. Rev. 84, 1243(1951)). About 30,000 decays in each element, with delays in the range 1 to 11 μsec, were counted. The contribution to the decay curves of the $\mu^+$ decay was estimated by computing the relative number of $\mu^+$ mesons stopped in the absorber, brass counter walls, and iron supports, assuming a $\mu^+$-meson mean life of $2.22 \pm 0.02$ μsec, as previously determined. The $\mu^-$-decay curve was then determined by subtracting the $\mu^+$ component from the measured composite ($\mu^+ + \mu^-$) curve. The $\mu^+$ and $\mu^-$ decay lifetimes are equal within the limits of experimental error. Data for each absorber include the fraction f⁻ of the total electron emission rate due to $\mu^-$ mesons, the composite ($\mu^+ + \mu^-$) mean life, the $\mu^-$-meson mean life, and the nuclear capture rate for the $\mu^-$ meson. (L.M.T.)

1204

EXCITATION FUNCTION FOR MESON PRODUCTION BY γ-RAY. Shigeo Minami. Progress Theoret. Phys. (Japan) 7, 535-8(1952) June.

The excitation function for the production of π mesons by γ rays is calculated by the Lorentz-covariant perturbation method, taking into account the effect of higher orders. For $\pi^0$-meson production various features have been obtained according to the theories adopted, while for charged π-meson production, nearly similar dependence of cross section upon the incident-photon energy has unanimously been obtained. (cf. NSA 6-4172) (auth)

1205

FORMATION OF π-MESON PAIRS BY PHOTONS ON NUCLEONS. G. F. Zharkov. Zhur. Eksptl'. i Teoret. Fiz. 22, 677-86(1952) June. (In Russian)

Formation of pairs of π mesons by photons on free nucleons is discussed. Two variants of interaction of pseudoscalar mesons with nucleons — pseudoscalar and a pseudovector — are investigated. It is shown that, in both cases, cross sections differ substantially in magnitude and angular dependence.

1206

NUCLEAR DISINTEGRATIONS BY SLOW NEGATIVE μ-MESONS AND PHOTONS. J. M. B. Lang. Proc. Phys. Soc. (London) A65, 995-1005(1952) Dec.

The emission of particles from a nucleus following the capture of a negative μ meson is discussed using evaporation theory. Assuming a reaction of the form $\mu^- + p \rightarrow n + \mu^0$, it is possible to calculate a distribution of nuclear excitation from which the mean probability of charged-particle emission is evaluated. In the relation between excitation U and nuclear temperature τ the exponent of τ is given the values 2 and 3. The usual law $U = \lambda\tau^2$ is found to predict results for proton emission which are far less than those experimentally observed. In order to investigate this energy-temperature relationship, data from low-energy photodisintegration experiments ($U \simeq 20$ Mev) have been compared with theoretical values. Combination of the limited evidence available with very high-energy data suggests a variation of excitation with the cube of the nuclear temperature. 23 references. (auth)

1207

τ-MESON DECAY IN FLIGHT. M. Annis and N. F. Harmon. Phys. Rev. 88, 1202-3(1952) Dec. 1.

The probable decay of τ mesons in flight has been observed in cloud-chamber pictures taken at Berthoud Pass, Colo. A particle entering the chamber penetrated 7 equal Pb thicknesses and split into three charged particles, each of which penetrated 4 more Pb thicknesses without interacting. On the basis of the recoil-nuclei energy, conservation of momenta, ionization, and penetrability associated with the particles, the event is suggested as the decay of a τ meson into three π mesons. (L.M.T.)

1208

EXCITATION FUNCTION FOR CHARGED π-MESON PRODUCTION IN HYDROGEN AND CARBON BY 345- to 380-MEV PROTONS. S. Passman, M. M. Block, and W. W. Havens, Jr. Phys. Rev. 88, 1247-53(1952) Dec. 15.

The 90° differential cross section for charged-meson production in hydrogen and carbon is measured for incident-proton energies 345 to 380 Mev. For hydrogen, the 90° $\pi^+$ meson-production energy spectra occur as peaks in the energy region predicted from the kinematics of the reaction $p + p \rightarrow \pi^+ + d$. Ratios of these 90° $\pi^+$ differential cross sections are $(d\sigma)/(d\omega)$ at 380 Mev: $(d\sigma)/(d\omega)$ at 365 Mev: $(d\sigma)/(d\omega)$ at 345 Mev = 2.6: 1.6: 1 with a statistical uncertainty of 15 percent. For carbon the $\pi^+$ meson-production spectra show an increase in the energy of the maximum of the broad distributions, with increasing incident-proton energy. The $(\pi^+)/(\pi^-)$ ratio in carbon is found to be in the range $(10 \pm 3) : 1$ for all three proton energies studies. Qualitative agreement with these carbon $\pi^+$ meson spectra is obtained from a phenomenological analysis based upon the assumptions of nucleon-nucleon collisions in which the target has a gaussian momentum distribution. 24 references. (auth)

1209

PRODUCTION OF CHARGED π-MESONS IN H, D, C, Cu, AND Pb BY 381-MEV PROTONS. M. M. Block, S. Passman, and W. W. Havens, Jr. Phys. Rev. 88, 1239-47(1952) Dec. 15.

The differential cross section for the production of charged π mesons at 90° from a 381-Mev proton beam has been measured in H, D, C, Cu, and Pb. Nuclear emulsions, imbedded in a tapered copper absorber, placed 90° below the internal-circulating proton beam of the Nevis cyclotron detected mesons of both signs, from 0 to 125 Mev. The beam was monitored by means of the $C^{11}$ activity produced in the target to determine the absolute cross section. The hydrogen and deuterium results were obtained by subtracting the carbon cross section from polyethylene and deuterated paraffin, respectively. Assuming the reaction in H is $p + p \rightarrow \pi^+ + d$ with a $\cos^2\theta$ angular distribution, the total cross section for H at 381 Mev is calculated from the 90° value to be $7.3 \pm 2.3 \times 10^{-28}$ cm². The spectra for heavy nuclei are calculated with the assumptions that meson production occurs through nucleon-nucleon collisions and that the meson receives the maximum available energy in the c.m. system. Good agreement with the experimental results is found for matrix elements proportional to meson momentum. The $\pi^+$ production cross section increases with a dependence slower than $A^{2/3}$, whereas the $\pi^-$ increases approximately as $A^{2/3}$. This asymmetry is also

found in the large $\pi^+/\pi^-$ ratio of 10 in carbon and about 25 in deuterium. 16 references. (auth)

1210

PRODUCTION OF $\pi^\circ$ MESONS IN HYDROGEN AND DEUTERIUM BY HIGH ENERGY $\gamma$ RAYS. G. Cocconi and A. Silverman. Phys. Rev. 88, 1230-3(1952) Dec. 15.

The angular distribution of the $\pi^\circ$s and the dependence of the cross sections on the energy of the $\gamma$ rays have been studied for the reactions

$$\gamma + p \rightarrow \pi^\circ + p,$$
$$\gamma + p \rightarrow \pi^\circ + d(p,n).$$

For the first reaction, the angular distribution in the center-of-mass system has the form $a + b \sin^2\theta$, with $a/b \simeq 1$, and the cross section is proportional to approximately the square of the excess energy of the $\gamma$ rays above the threshold; $\sigma_D/\sigma_H \simeq 2$ at all energies and angles. (auth)

1211

PRODUCTION OF $\pi^\circ$ MESONS BY $\gamma$-RAYS ON HYDROGEN. A. Silverman and M. Stearns. Phys. Rev. 88, 1225-30(1952) Dec. 15.

The production of $\pi^\circ$ mesons in the reaction $\gamma + p \rightarrow \pi^\circ + p$ is investigated as a function of the incident $\gamma$-ray energy in the region from 200 to 300 Mev. For the $\pi^\circ$ emitted at approximately 90°(lab), the differential cross section can be represented by $(d\sigma_\pi^\circ/d\Omega)_{\pi/2} = C(K - 145)^{1.9 \pm 0.4}$, where K = energy of incident $\gamma$ ray in Mev. The approximate threshold for the reaction is 145 Mev. The ratio of the cross section at 60° (lab) to that at 90°(lab), for $\gamma$ rays between 250 and 300 Mev, is 1.45 ± 0.25. (auth)

*METEOROLOGY*

1212

Hanford Works

STUDIES OF DIFFUSION IN THE ATMOSPHERE; PROGRESS REPORT NUMBER ONE, by B. Shorr. Mar. 18, 1952. 44p. (HW-24049)

During the past nine months, a series of field tests dealing with problems of diffusion in the lower atmosphere has been carried out as part of the experimental-meteorology program. The primary objective of these field tests has been the design of experiments to test the applicability of various diffusion hypotheses to the Hanford Works area. In view of the fact that there is insufficient evidence to indicate that the available theories have general applicability, the question of employing them at the Hanford Works is a serious one. It is the purpose of this report to indicate the nature of some of the problems and discuss the techniques being developed, the facilities being used, and some preliminary results obtained from the first series of experiments. (auth)

*MOLECULAR PROPERTIES*

1213

Los Alamos Scientific Lab.

KINETICS ANALYSIS OF FLOW CATALYSIS OF ORTHO TO PARA HYDROGEN, by J. D. Rogers. [nd] 11p. (AECU-1972(rev.); LADC-1272)

The catalytic conversion of ortho to para hydrogen at liquid nitrogen temperatures is considered for several chromium oxide catalysts. The reaction is monomolecular in both directions and reversible with reaction on the catalyst surface, involving a single site mechanism, controlling. Combinations of the kinetics constants and adsorption constants, as involved in the defining rate equation, are given. (auth)

*NEUTRONS*

1214

NOTES ON THE DECAY OF THE NEUTRON. I. Tsuneyuki Kotani, Hisao Takebe, Minoru Umezawa, and Yoshio Yamaguchi. Progress Theoret. Phys. (Japan) 7, 469-80 (1952) May.

The beta decay of the neutron is theoretically discussed and compared with the experimental results of Robson. As was first pointed out by Berectetsky and Pomeranchuk, the form of the beta spectrum derived on the pseudoscalar interaction is different from the so-called allowed spectrum. The final decision about the type of interaction is not, however, offered from the beta spectrum alone. Attempts are therefore made to obtain some theoretical predictions which might be useful for the decision of the interaction type when compared with some future experiments. They are the angular correlation of electrons and protons and the momentum spectrum of protons. The calculation shows that in principle it is possible, though not easy, to carry through such experiments. The beta spectrum obtained by Robson is not reliable in the low-energy region, but an explanation is given how to account for the shape of the spectrum in this region, if the observed spectrum is correct there. 14 references. (auth)

*NUCLEAR PHYSICS*

1215

DEPENDENCE OF GAMMA-RADIATION LIFETIMES ON NUCLEON CONFIGURATIONS. R. D. Hill. Phys. Rev. 88, 1428-9(1952) Dec. 15.

The squares of the matrix element $|M|^2$ (M is $\tau_\gamma$(theoretical)/$\tau_\gamma$(experimental) for all the evaluable E3 transitions of the $^7/_2+ \rightleftharpoons p_{1/2}$ type are plotted against a number n, representing the complexity of the nucleon configuration. For the odd-proton nuclei, n is the number of protons coupling to form the $^7/_2+$ state, and for odd-neutron nuclei, n is the number of neutron holes in the configuration forming the $^7/_2+$ state. It is seen from the plot that $|M|^2$ increases steeply with n. The differences in $|M|^2$ are attributed to the differences in nucleon electric moment of the $^7/_2+$ states. (L.M.T.)

1216

A SIMPLE PICTURE OF THE PHENOMENA OF NUCLEAR FISSION. Daniel Curie. Compt. rend. 235, 1286-8(1952) Nov. 24. (In French)

In order to explain the asymmetry of the fission process, the author considers the U nucleus to be made up of a saturated core surrounded by a membrane of nucleons; fission consists in the ripping of this membrane. The model is applied to the shape of the fission-yield curve and to the variation of spontaneous fission half lives as a function of $Z^2/A$. (tr-auth)

*NUCLEAR PROPERTIES*

1217

HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF $Xe^{129}$ AND $Xe^{131}$. Aage Bohr, Jørgen Koch, and Ebbe Rasmussen. Arkiv Fysik 4, 455-68(1952).

By means of an electromagnetic isotope separator, targets have been prepared containing the odd xenon isotopes $Xe^{129}$ and $Xe^{131}$ in great purity. With these targets as electrodes in a Geissler tube, the infrared spectrum of XeI has been investigated with a Fabry-Perot interferometer. The hfs of a number of lines has been measured and the splittings of 1 s and 2 p terms have been determined. The data yield directly the ratio $\mu_{129}/\mu_{131} = -1.131 \pm 0.005$. From the deviations from the Landé interval rule, the quadrupole moment of $Xe^{131}$ was estimated to be $-0.12 \times 10^{-24}$ cm$^2$. In this estimate, use was made of the magnetic-moment ratio to find term splittings which could not be directly measured. A theoretical analysis of the 1 s and 2 p terms of XeI is made on the basis of the hfs data. The results are compared with the information obtained from Zeeman effect and multiplet structure. (auth)

1218

POLARIZED $\gamma$-RAYS FROM NUCLEI ALIGNED AT LOW TEMPERATURES. G. R. Bishop, J. M. Daniels, G.

Goldschmidt, H. Halban, N. Kurti, and F. N. H. Robinson. Phys. Rev. 88, 1432-3(1952) Dec. 15.

The technique of Daniels and Gorte (Nature 168, 780 (1951), Physica 17, 1050(1951)) was used to align $Co^{58}$ and $Co^{60}$ nuclei for polarization observations. A stack of single crystals containing the desired radioactive Co was mounted in a demagnetization cryostat with the b axis and the $K_1$ axis both horizontal. The two axes of alignment in these crystals each made an angle of 53° with the b axis. Radiations emitted along the b axis were observed using a polarimeter. Radiation is collimated on to a liquid scintillator where it is scattered, and that which is scattered through 90° in the horizontal and vertical directions is detected by two NaI crystals. The coincidence counting rates between the liquid scintillator and each NaI crystal gave the number of $\gamma$ rays scattered in each direction. The salt was cooled by adiabatic demagnetization to a temp. of ~0.01°K and as the salt warmed up to 1°K the coincidence rates were observed. Plots are given of the ratio of coincidence rates normalized to the ratio at 1°K vs. 1/T for both $Co^{58}$ and $Co^{60}$. (L.M.T.)

1219

NUCLEAR QUADRUPOLE SPECTRA IN TWO TRIALKYL-BORONS. H. G. Dehmelt. Z. Physik 133, 528-31(1952). (In German)

Nuclear quadrupole spectra of $B^{10}$ and $B^{11}$ in solid $B(CH_3)_3$ and $B(C_2H_5)_3$ were measured. The ratio of their quadrupole moments was found to be $Q^{10}/Q^{11} = 2.084 \pm 0.002$. In both compounds, the eccentricity parameter $\epsilon$ was <1%. The quadrupole moments were estimated to be $Q^{10} = +0.105 \times 10^{-24}$ cm$^2$ and $Q^{11} = +0.051 \times 10^{-24}$ cm$^2$. (tr-auth)

1220

ENERGY LEVELS OF LIGHT NUCLEI. IV. F. Ajzenberg and T. Lauritsen. Revs. Modern Phys. 24, 321-402(1952) Oct.

In this survey is included all the available (as of Aug. 1952) experimental material bearing on the energy levels of the nuclides from $He^5$ up to and including the Ne isotopes. Generally speaking, very-high-energy reactions, leading to multiple-particle emission or spallation have not been included, nor have the very-high-energy scattering experiments. In view of the recent and impending appearance of a number of theoretical papers dealing with the problems of the light nuclei, the authors have made only occasional references to the theory, without attempting to present a detailed account of its application to specific nuclides. In almost all cases, sufficient new material has appeared on the reactions included in the 1950 summary (NSA 5-1104) to justify complete revision of the text. In the instances where no new work exists, the authors have repeated the earlier version in an abbreviated form or simply cited the previous summary. ~700 references. (G.Y.)

1221

THE INHERENT HALF-WIDTH OF K-CONVERSION LINES. Hilding Slätis and Gunnar Lindström. Phys. Rev. 88, 1429(1952) Dec. 15.

The broadening effect in the $\beta$ spectrum of ThB was measured. The $I_a$ line (an $L_{II}$ line) had a half width of only 1.2 parts in 10,000 and the G and H lines, which are K lines, were found to be 3 parts in 10,000 broader. This effect corresponds to about 80 ev in energy and seems to be the same for all K-conversion lines in the ThB $\beta$ spectrum. An explanation of this inherent line width of K-conversion lines is suggested. (L.M.T.)

1222

THE NUCLIDES $Ba^{127}$, $Ba^{128}$, AND $Cs^{128}$. M. Linder and R. N. Osborne. Phys. Rev. 88, 1422-3(1952) Dec. 15.

Further investigations of the isobaric chain $Ba^{128} \rightarrow Cs^{128} \rightarrow Xe^{128}$ yielded the following results: (1) three independent half-life determinations of $Cs^{128}$ yielded 3.80, 3.75, and 3.8 minutes, (2) essentially all of the activity in the 2.4-day $Ba^{128}$ decay is due to $Cs^{128}$, (3) $Ba^{128}$ decays principally by electron capture, (4) K x radiation is associated with the 3.8-min $Cs^{128}$, (5) if the $Cs^{128}$ x rays be due to electron capture rather than $\gamma$ conversion, ~25% of the $Cs^{128}$ decays through electron capture, and (6) a Ba activity of 12-min half life was found and assigned to $Ba^{127}$. (L.M.T.)

1223

NEUTRON TOTAL CROSS SECTIONS. E. R. Hodgson, J. F. Gallagher, and E. M. Bowey. Proc. Phys. Soc. (London) A65, 992-4(1952) Dec.

The neutron total cross sections of Be, Na, Mo, and Hg have been measured in the energy region 1 ev to 10 kev, and of Th between 1 ev and 1 kev, using the Harwell linear accelerator time-of-flight spectrometer. The energy resolution is better than in previously reported work on these elements, and several resonances have been more clearly resolved. (auth)

1224

RELATIVE PAIR PRODUCTION CROSS SECTION AT LOW ENERGIES. G. M. Griffiths and J. B Warren. Proc. Phys. Soc. (London) A65, 1050-2(1952) Dec.

In the course of testing scintillation spectrometers it was found that the "pair peaks" due to $\gamma$ rays of energy only slightly in excess of the pair production threshold could be resolved. The relative pair production cross sections, using the cascade $\gamma$ rays from $Na^{24}$ (2.765 and 1.380 Mev) and $Co^{60}$ (1.332 and 1.171 Mev), were determined by comparing the ratio of the areas under the two "pair peaks." The experimental values are somewhat lower than the theoretical values from the Bethe-Heitler formula as given by Hough (Phys. Rev. 73, 266(1948)). (L.M.T.)

1225

SECOND-ORDER EFFECTS IN NUCLEAR ELECTRIC QUADRUPOLE INTERACTION OF $Al^{27}$ IN SPODUMENE. H. E. Petch, G. M. Volkoff, and N. G. Cranna. Phys. Rev. 88, 1201-2(1952) Dec. 1.

In an earlier paper (Can. J. Phys. 30, 270(1952)) the electric quadrupole splitting of nuclear magnetic resonance absorption lines in single crystals was carried through only to terms of the first order in the quadrupole coupling constant. Generalizations of Pound's theory (Phys. Rev. 79, 685(1950)) have been extended to the second order and checked experimentally on the $Al^{27}$ resonance in spodumene. Results are reported here only for the central component ($\frac{1}{2} \rightarrow -\frac{1}{2}$) in the $Al^{27}$ ($I = \frac{5}{2}$) line. Complete treatment is given in a paper to be submitted to the Canadian Journal of Physics. (L.M.T.)

1226

LIMIT ON REPULSIVE CORE FROM 100-MEV DEUTERON PHOTOEFFECT. N. Austern. Phys. Rev. 88, 1207-8(1952) Dec. 1.

Theoretical treatment is given of the effects produced in 100-Mev deuteron photodisintegration by a repulsive core potential for the ground state. A plot is given of the deuteron photodisintegration cross sections expressed in terms of the cross sections of Schiff, Marshall, and Guth (Phys. Rev. 78, 733(1950)) which are computed in terms of the Hulthén type ground-state wave function. The experimental points of Benedict and Woodward (Phys. Rev. 85, 924(1952)) are also included on the plot. It is seen from the plot that the 100-Mev effect remains slight until the core radius becomes large. The upper limit on the core radius seems to be about $0.8 \times 10^{-13}$ cm. (L.M.T.)

1227

ENERGY LEVELS IN MAGNESIUM, VANADIUM, CHROMIUM, AND MANGANESE. H. J. Hausman, A. J. Allen, J. S. Arthur, R. S. Bender, and C. J. McDole. Phys. Rev. 88, 1296-9 (1952) Dec. 15.

Targets of Mg, V, Cr, and Mn have been bombarded by 8-Mev protons from the 47-in. cyclotron and the reaction

particle observed at an angle of 150° to the incident beam. Three levels are assigned to $Mg^{24}$, seven to $Mg^{25}$, and two to $Mg^{26}$. Fourteen levels are reported for $V^{51}$, 15 for Cr, and 15 for $Mn^{55}$. (auth)

1228

A NUCLEAR RESONANCE MODULATION CORRECTION. M. M. Perlman and M. Bloom. Phys. Rev. 88, 1290-1(1952) Dec. 15.

A theoretical modulation correction with experimental justification is derived. It is found that the experimentally measured value of the second moment is always larger than the true value by an amount $\frac{1}{3}$ $Hm^2$ where Hm is the modulation amplitude. The correction holds even for amplitudes close to the line width and gives consistently good results when applied to the analysis of line shapes. (auth)

1229

NUCLEAR ENERGY LEVELS IN THE REGION OF THE 28-NEUTRON SHELL. George F. Pieper. Phys. Rev. 88, 1299-1305(1952) Dec. 15.

Energy levels of the titanium nuclei of mass numbers 47, 48, 49, 50, and 51 have been obtained by measuring the ranges of proton groups from the series of reactions Ti(d,p)Ti. With the use of enriched isotopes, it has been possible to assign thirty observed Q values to their proper reactions. Good agreement was found in most cases in which results of this study could be compared with the results of others. The data have been analyzed in terms of the strong spin-orbit-coupling shell model of nuclear structure. A study of the binding energy of each residual nucleus and the energy of its first excited state revealed definite evidence for the existence of a closed shell at 28 neutrons. 30 references. (auth)

1230

NUCLEAR SPECTRA OF $Rb^{82}$ AND $Rb^{84}$. Charles M. Huddleston and Allan C. G. Mitchell. Phys. Rev. 88, 1350-4(1952) Dec. 15.

The nuclear spectra of $Rb^{82}$ (6.3 hr) and $Rb^{84}$ (34 days) have been measured with a magnetic-lens spectrometer. $Rb^{82}$ emits two positron groups of energies 0.775 and 0.175 Mev. It also decays by orbital electron capture. A large number of gamma rays accompanies the disintegration. Reasonable agreement with the gamma rays emitted by $Br^{82}$ has been obtained. $Rb^{84}$ emits three groups of positrons having end-point energies of 1.629, 0.822, and 0.373 Mev. One gamma ray whose energy is 0.890 Mev has been found. Level diagrams for these disintegrations are discussed. (auth)

1231

TOTAL NEUTRON CROSS SECTION OF SODIUM. P. H. Stelson and W. M. Preston. Phys. Rev. 88, 1354-7(1952) Dec. 15.

The total neutron cross section of sodium has been measured over the energy range 120 to 1000 kev using resolutions of 2.5 to 5 kev. A number of resonances, corresponding to excited states in the compound nucleus $Na^{24}$ were investigated. In some cases it is possible to assign J and l values and to compute the effective level spacings $D_J^l$. Evidence is given to show that the $D_J^l$, which are a measure of the complexity of a state, differ by a factor of 8 for two states of the same type and at approximately the same excitation energy (7.5 Mev) in the $Na^{24}$ nucleus. An anomalous S-wave resonance at 300 kev suggests that the potential scattering may be spin dependent. (auth)

*NUCLEAR REACTORS*

1232

Oak Ridge School of Reactor Tech.

HEAT TRANSFER PROBLEMS IN A LOW COST NUCLEAR REACTOR (thesis), by William Aaron Berger. 1952. 45p. (CF-52-8-102)

The Low Cost Reactor is a nuclear reactor about 2 ft high, 1.25 ft long, and 1 ft wide suspended in a pentagonal pool of water 27 ft long, 12 ft wide, and 26 ft deep. The fuel elements are made up of five sandwiched plates of a 20% $U^{235}$-Al alloy center portion and 2S Al cladding. For 1000-kw operation with forced circulation of pool water through the reactor, the following heat-transfer problems are discussed: cooling water required, pump size, heat-exchanger requirements, temperature distribution in cooling water and fuel plates, and power level at which boiling of the cooling water occurs for the above determined conditions. For 100-kw operation with free convection cooling, temperature distribution in the cooling water, power level at which boiling of the cooling water occurs, and equilibrium temperature of the pool and external cooling of pool water required are studied. Abnormal conditions brought about by sudden loss of water from the pool while running at power and resulting temperature distribution in the fuel elements as a function of time and position also are discussed. (G.Y.)

*NUCLEAR TRANSFORMATION*

1233

Radiation Lab., Univ. of Calif., Berkeley

THE PRODUCTION OF HIGH ENERGY DEUTERONS BY THE STRIPPING OF $He^3$; PHOTOPRODUCTION OF NEUTRAL MESONS FROM DEUTERIUM (thesis), by Warren Heckrotte. Apr. 14, 1952. 81p. (UCRL-1868)

In the first part of the paper the expected yield of deuterons from the stripping of $He^3$ and the angular and energy distributions are calculated. In the second part the photoproduction of $\pi^0$ mesons from D is considered. The determination of the relative sign of the proton and neutron coupling constants is possible from an experimental study of $\pi^0$ meson production from D. Two different reactions leading to the photoproduction are considered. In the first, that which leads to deuteron formation in the final state (the elastic case), it is shown that the total cross sections for the cases $g_p = -g_n$ and $g_p = g_n$ differ by a factor of 25. The angular distributions for the two cases are almost identical. In the second, the inelastic case, which corresponds to unbound neutron and proton in the final state, it is found that there is only a slight difference in the total cross sections between the cases $g_n = g_p$ and $g_p = -g_n$. The difference is a factor of 2 or 3. The angular distributions differ appreciably. (L.T.W.)

1234

Radiation Lab., Univ. of Calif., Berkeley

SUMMARY OF THE RESEARCH PROGRESS MEETINGS OF AUGUST 21 AND 28, AND SEPTEMBER 11, 1952, by Sergey S. Shewchuck. Nov. 11, 1952. 4p. (UCRL-2007)

Thermal Conductivity of Gases at Moderate Pressures. L. Bromley. The talk was based on report UCRL-1852 of the same title. Angular Distribution of Positive Pions from the Reaction $p + d \rightarrow \pi^+ + t$. W. J. Frank. Preliminary results are given for the differential cross section of reaction for various triton center-of-mass angles. (L.T.W.)

1235

ANGULAR DISTRIBUTION OF THE GAMMA RAYS FROM THE REACTION $N^{15}(p,\alpha\gamma)C^{12}$. C. A. Barnes, D. B. James, and G. C. Neilson. Can. J. Phys. 30, 717-8(1952) Nov.

The angular distribution of the $\gamma$ radiation from the 429-, 898-, and 1210-kev resonances in the reaction $N^{15}(p,\alpha\gamma)C^{12}$ was measured. On the assumption that $N^{15}$ has spin $\frac{1}{2}$ and odd parity, and that the $C^{12}$ ground state and the $\alpha$ particle have zero spin and even parity, the assignments of spin and parity are consistent with the observed distributions. (L.T.W.)

1236

SOME INVESTIGATIONS OF $(p,\alpha)$ REACTIONS ON THIN SEPARATED $O^{18}$ AND $N^{15}$ TARGETS; TECHNIQUES AND

RESULTS. C. Mileikowsky and R. T. Pauli. Arkiv Fysik 4, 299-322(1952)

The reactions (p,α) were investigated for $O^{18}$ and $N^{15}$ by means of the 1.5-Mv heavy-particle accelerator and analyzing magnet (Arkiv Fysik 4, 287-98(1952)). The isotopes were electromagnetically separated onto Ag backing plates of 20-mm diameter and 3-mm thickness. Proportional counters were used for the identification of the reactions and the investigation of the excitation curves; scintillation counters were also investigated for α-particle detection. The range curves obtained for the α particles agree well with the range expected from the calculated Q values. The excitation curves showed resonances at 680 kev for the $O^{18}(p,\alpha)N^{15}$ reaction and at 340 kev for the $N^{15}(p,\alpha)C^{12}$ reaction. In general, it is concluded that electromagnetically separated thin targets can be successfully used in nuclear reaction studies. (L.M.T.)

1237

INDUCTION OF NUCLEAR DIPOLE VIBRATIONS BY FAST ELECTRONS. F. Schlögl. Z. Physik 133, 485-98(1952). (In German)

Reaction cross sections for inelastic scattering by nuclei of electrons with energies >20 Mev resulting in induction of dipole vibrations have been calculated. The scattering is strongly directional dependent, and the induced nuclear vibrations are to a high degree oriented normal to the direction of the incident electron. The computations are carried out in detail for $C^{12}$. (tr-auth)

1238

EXCITATION OF NUCLEI BY THE COULOMB FIELD OF CHARGED PARTICLES. K. A. Ter-Martirosyan. Zhur. Eksptl'. i Teoret. Fiz. 22, 284-96(1952) Mar. (In Russian)

An example of a semiclassical computation of the probability of nuclear excitation under the action of an electric field produced by a heavy charged particle is presented.

1239

EXCHANGE COLLISIONS OF FAST NUCLEONS WITH DEUTERONS. II. I. Ya. Pomeranchuk. Zhur. Eksptl'. i Teoret. Fiz. 22, 624-7(1952) May. (In Russian)

The effective cross section for exchange collisions of fast nucleons with deuterons for which the momenta of slow nucleons are given is obtained. The possibility of analyzing the spin dependence of the exchange forces is seen in the experimental study of such collisons.

1240

(γ,α) REACTIONS ON $Li^7$, $O^{16}$, $Br^{79}$, and $Br^{81}$. H. Nabholz, P. Stoll, and H. Wäffler. Helv. Phys. Acta 25, 701-24(1952) Dec. 15. (In German)

Experiments summarized in a letter to the editor (Phys. Rev. 86, 1043-4(1952); NSA 6-4952), are here reported in detail. (G.Y.)

1241

THE MASS DIFFERENCE OF SULPHUR 32 AND CHLORINE 35. A. Folkierski. Proc. Phys. Soc. (London) A65, 1006-15(1952) Dec.

The Q values of the reactions $S^{32}(\alpha,p)Cl^{35}$ and $Cl^{35}(n,\alpha)P^{32}$ were measured as $-2.02 \pm 0.11$ and $+1.07 \pm 0.15$ Mev, respectively. From these Q values and from the β-decay energy of $P^{32}$ the difference in mass excess of $S^{32}$ and $Cl^{35}$ was calculated in two independent ways, giving $1.96 \pm 0.11$ and $1.98 \pm 0.15$ Mev. In the investigation of the (α,p) reaction the nuclear emulsion technique was used in conjunction with α particles from ThC'. An ionization chamber was used to measure the α-particle energy in the case of the (n,α) reaction which was excited by fast neutrons obtained from the d-d process. 18 references. (auth)

1242

THE FORBIDDEN NATURE OF THE REACTION $^6Li(\gamma d)^4He$ for γ-RAYS OF ENERGIES UP TO 17.6 MEV. E. W. Titterton and T. A. Brinkley. Proc. Phys. Soc. (London) A65, 1052-3(1952) Dec.

Searches for the $Li^6(\gamma,d)He^4$ reaction have given negative results, the upper limit of the cross section up to 17.6 Mev determined as $\leq 5 \pm 2 \times 10^{-30}$ cm$^2$. Latest evidence for an explanation of the "forbidden nature" of this reaction is that at the γ-ray energies of the experiment, such levels as can be excited are prevented from breaking up into a deuteron and an α particle by selection rules. Further work will be done at intermediate energies and work is already in progress with plates exposed to 24-Mev bremsstrahlung from a synchrotron. (L.M.T.)

1243

SPONTANEOUS FISSION VERSUS ALPHA-DECAY. Arnold Kramish. Phys. Rev. 88, 1201(1952) Dec. 1.

From Frenkel's suggestion (J. Phys. (U.S.S.R.) 10, 533 (1946)), α decay and spontaneous fission should be regarded as closely related but competitive decay processes for heavy nuclei. As a measure of this competition the ratio of the spontaneous-fission half life to the α-disintegration half life has been plotted against $Z^2/A$ for several of the heavier nuclei. It is seen from the plot that the spontaneous fission mode of decay becomes more predominant as $Z^2/A$ increases for even-even nuclei, while the opposite appears to be true for odd-neutron nuclides. Thus it is reasoned that for odd-neutron nuclides α decay may be more competitive, thereby accounting for the anomalously slow spontaneous fission rate which has been observed. (L.M.T.)

1244

THE AVERAGE ELECTRIC CHARGE OF DAUGHTER ATOMS FROM β-DECAY AND ISOMERIC TRANSITION. Sol Wexler and T. H. Davies. Phys. Rev. 88, 1203-4(1952) Dec. 1.

Experiments have been performed to determine the average positive charge found on the products of β-decay of $H^3$ present as molecular hydrogen, of $C^{14}$ as $CO_2$, and of a mixture of Kr and Xe fission gases. Results are also reported for 18-min $Br^{80}$ from the transition of 4.4-hr $Br^{80m}$ present as $C_2H_5Br$. Cylindrical or spherical ion chambers with a small central collector electrode at 1000 to 1500 volts negative potential with respect to the outer shell were filled with the radioactive gases at $5 \times 10^{-5}$ to $1.5 \times 10^{-3}$ mm Hg. A grid about the central collector at 100 to 200 volts higher negative potential returned secondary electrons to the collector. Ion currents measured by means of an attached dynamic-condenser electrometer averaged about unity for the β-decay products. An average of about +10 for the $Br^{80}$ (twice the predicted value) can probably be explained by the decay of $Br^{80m}$ by two successive isomeric transitions. (L.M.T.)

1245

ENERGY LEVELS IN LIGHT NUCLEI. J. C. Arthur, A. J. Allen, R. S. Bender, H. J. Hausman, and C. J. McDole. Phys. Rev. 88, 1291-5(1952) Dec. 15.

Targets of beryllium, Nylon, lead fluoride, sulfur, and lead sulfide were bombarded with 8-Mev protons from the University of Pittsburgh cyclotron. Energy levels were observed in $Be^9$, $C^{12}$, $N^{14}$, $O^{16}$, $F^{19}$, and $S^{32}$ by inelastic scattering at 150° from thin targets. Single levels were assigned in $Be^9$ and $C^{12}$; two levels were assigned in $N^{14}$; nine levels were assigned in $F^{19}$; and seven levels were assigned in $S^{32}$. 15 references. (auth)

1246

THE REACTION ENERGIES OF $Ne^{21}(d,\alpha)F^{19}$ and $Ne^{21}(d,p)Ne^{22}$ FROM MAGNETIC ANALYSIS. Curt Mileikowsky and Ward Whaling. Phys. Rev. 88, 1254-7(1952) Dec. 15.

Separated isotopic targets of $Ne^{21}$, which were produced at the Nobel Institute of Physics, have been used to measure the Q values of the reactions (1) $Ne^{21}(d,\alpha)F^{19}$, and (2) $Ne^{21}(d,p)Ne^{22}$. A double-focusing magnetic spectrograph was used

to compare the energy of the protons and alpha particles from these reactions with the alpha particles from ThC and ThC'. The angle of observation and the deuteron bombarding energy were chosen so that the particles being studied and the alpha line used for energy calibration lay nearly side by side on the photographic plate used as a detector. The Q values measured are 6.432 ± 0.010 Mev for reaction (1) and 8.137 ± 0.011 Mev for reaction (2). From these Q values and the mass of $F^{19}$ the atomic masses of $Ne^{21}$ and $Ne^{22}$ are obtained. Other alpha groups from reaction (1) correspond to transitions to states in $F^{19}$ at 0.113 ± 0.008 Mev and 0.192 ± 0.012 Mev above the ground state. Additional particle groups from N and Na contamination on the targets have been observed: The Q values measured are 8.613 ± 0.011 Mev for $N^{14}$(d, p) $N^{15}$ and 4.723 ± 0.008 for $Na^{23}$(d, p)$Na^{24}$. 15 references. (auth)

1247

MAGNETIC ANALYSIS OF THE $F^{19}(d,p)F^{20}$ AND $F^{19}(d,\alpha)O^{17}$ REACTIONS. H. A. Watson and W. W. Buechner. Phys. Rev. 88, 1324-31(1952) Dec. 15.

The energy spectrum of protons from the $F^{19}(d,p)F^{20}$ reaction has been analyzed at 90° to the incident-deuteron beam, using an annular magnetic spectrograph with photographic detection. Nineteen proton groups have been observed and identified with this reaction. These correspond to the ground state of $F^{20}$ and eighteen excited states in the range of excitation from 0 to 5.1 Mev. Deuteron-bombarding energies ranging from 1.5 to 2.1 Mev were used. Tracks of alpha particles, arising from the $F^{19}(d,\alpha)O^{17}$ reaction, were also observed on the photographic plates. Alpha-particle groups corresponding to the ground state and ten excited levels of $O^{17}$ in the range of excitation from 0 to 6.9 Mev were identified. Some of the groups corresponding to $O^{17}$ levels of sufficient excitation to be unstable against neutron decay exhibited a broadening which may result from the natural width of the corresponding $O^{17}$ levels. 17 references. (auth)

*PARTICLE ACCELERATORS*

1248

NOTES ON THE 225-CM CYCLOTRON AT THE NOBEL INSTITUTE FOR PHYSICS, STOCKHOLM. Hugo Atterling and Gunnar Lindström. Arkiv Fysik 4, 559-63(1952).

The initial performance and additional design features of the 225-cm cyclotron are presented. This conventional-type, constant-frequency instrument was designed to produce 25-Mev deuterons but in the initial tests only 21-Mev deuterons were obtained. Considerable discussion is given of the r-f system, inasmuch as this seems to have caused the greatest amount of trouble. (L.M.T.)

1249

THE ENERGY SPECTRUM OF THE X RAYS FROM A 70-MEV. SYNCHROTRON. I. B. McDiarmid. Can. J. Phys. 30, 670-83(1952) Nov.

The spectrum of the x rays produced in the forward direction by 70-Mev electrons striking a very thick target has been measured. The scattering method has been used to determine the energies of about 650 electron pairs produced by the x rays in G-5 emulsions and from this spectrum has been deduced. The number of photons found below 25 Mev is considerably less than that expected from the Bethe–Heitler–Schiff theory. No satisfactory explanation of this has been found but the measured spectrum is in agreement with "yield" measurements done in this laboratory. (auth)

1250

A 1.5 MV ACCELERATOR FOR HEAVY PARTICLES WITH ANALYZING MAGNET FOR USE IN NUCLEAR RESEARCH. C. Mileikowsky and R. T. Pauli. Arkiv Physik 4, 287-98 (1952).

A complete description is given of the design of the cascade generator and accelerating tube used in the 1.5-Mv heavy-particle accelerator including the vacuum system and the r-f ion source. The ion optics of the accelerating tube are discussed and the analyzing magnet and regulating devices are dealt with briefly. Preliminary performance tests have been made but adjustment for the top limits of performance hasn't yet been achieved. (L.M.T.)

*RADIATION ABSORPTION AND SCATTERING*

1251

Sarah Mellon Scaife Radiation Lab., Univ. of Pittsburgh

THE EFFECT OF A HIGHLY SINGULAR TRIPLET TENSOR INTERACTION OF THE P-P SCATTERING BELOW 10 MEV, by Edwin A. Crosbie. Jan. 1952. 49p. (NP-4295; U20875; Report No. 1)

Theoretical calculations indicate that proton-proton experiments performed at 8 Mev with an accuracy of 1% should be sufficient to detect the highly singular tensor interaction shown by Christian and Noyes to apply to 340 Mev (Phys. Rev. 78, 85-95(1950)). The calculations are made with the assumption that only the S and P waves are affected by the nuclear singlet and tensor interactions, respectively. Comparison with the 6.85-Mev data of Rouvina (Phys. Rev. 81, 593-601(1951)) indicates that the tensor interaction predicted at 32 and 340 Mev by Christian and Noyes is invalid. As low-energy data become more accurate, a limitation of the values of the parameters used in the triplet interactions should become possible. (TID-LC)

1252

MEASUREMENTS OF FLUCTUATIONS OF IONIZATION LOSSES FOR ELECTRONS IN THIN LAYERS OF SUBSTANCES. V. S. Shpinel. Zhur. Eksptl'. i Teoret. Fiz. 22, 421-4(1952) Apr. (In Russian)

In a $\beta$ spectrometer, curves of distribution of ionization losses in Al 1.65 and 3.96 mg/cm$^2$ thick were measured for electrons of energies of 148 and 222 kev. Experimental values of probable losses agree well with theory, provided correction is made for the longer path due to scattering. However, the obtained distribution is noticeably wider than in the theoretical curve of Landau.

1253

EXCITATION AND IONIZATION FUNCTIONS FOR FAST-ELECTRON COLLISION. W. Hanle and D. Riede. Z. Physik 133, 537-40(1952). (In German)

Quantum yields and ionization functions for collision in He, A, and Xe of fast electrons (up to 15 kev) were measured and are compared with the theoretical excitation function for optically permitted transitions. The curves for the several gases have the same slopes from 2 kev on and differ only in the absolute values of the yields, in agreement with prediction. (G.Y.)

1254

THE THEORY OF THE DEUTERON STRIPPING REACTION. R. Huby. Proc. Roy. Soc. (London) A215, 385-98(1952) Dec. 5.

The differential cross section for deuteron stripping reactions at energies several million electron volts above the coulomb barrier is calculated by a method which is essentially that of Butler as regards physical assumptions and line of argument, but which employs a different mathematical technique and notation at many points, for reasons of clarity and exactitude. The procedure is assimilated into the S-matrix formalism. The essence of the method is the smooth joining up of the wave function for the nucleon stripped off, and the derivative of this wave function, on the two sides of the surface of the target nucleus. The formula obtained is discussed, to show how the various factors arise from the successive physical stages by which the reaction proceeds.

New features are (a) the cross section is now given explicitly for the case in which the stripped nucleon is captured into a virtual state, as well as for the case of a bound state, as hitherto; (b) the factor determining the absolute magnitude of the cross section is given explicitly in a form which would permit of estimates being made of it. (auth)

1255

ANGULAR DEPENDENCE OF INELASTIC SCATTERING OF PROTONS ON $Be^9$. K. E. Davis. Phys. Rev. 88, 1433-4(1952) Dec. 15.

The angular dependence of inelastic scattering of protons was determined for scattering angles between 20 and 160° in the 2.4-Mev level of $Be^9$ using a modified form of camera developed by Wilkins (Phys. Rev. 55, 1134(1939)). Al-stopping foils were interposed between the target and the various detector plates (Eastman NTB plates 1 × 3 in.) so as to reduce the track length and resultant background of elastically scattered protons and at the same time make the tracks of inelastically scattered protons shorter and more easily recognized. The scattering is isotropic over the 60 to 160° range but rises to ~3 times the 60 to 160° values at 20°. Possible explanations are advanced for this, but it is pointed out that information would have to be secured at angles as small as 10° to test the explanations. (L.M.T.)

1256

NOTE ON THE NON-RELATIVISTIC LIMIT OF THE COMPTON SCATTERING. S. Goto. Progress Theoret. Phys. (Japan) 7, 585-6(1952) May-June.

Thirring (Phil. Mag. 41, 1193(1950)) has shown the disappearance of the Thomson limit of Compton scattering by Fermi particles. In this note it is shown that the same results can be obtained from only the Lorentz covariance and the gage invariance. (auth)

1257

ON THE MODEL OF V-PARTICLE AND MESON-NUCLEON SCATTERING. K. Sawada. Progress Theoret. Phys. (Japan) 7, 592-5(1952) May-June.

In this discussion, the existence of V′ particles (mass ~2800 $m_e$) as the parent of V particles is assumed and the effect on meson-nucleon scattering calculated. Its effect on the coupling constant and meson-nucleon scattering cross section is shown to be quite large. (L.M.T.)

1258

NEUTRON-PROTON SCATTERING. H. N. Yadav. Indian J. Phys. 35, 337-46(1952) July.

The angular distribution and the total cross section have been calculated for incident 83-Mev neutrons scattered by protons. Interactions considered are of symmetrical type and one with interaction in the even states only, for Yukawa potential with ranges $1.18 \times 10^{-13}$ cm for singlet states, $0.80 \times 10^{-13}$ cm for the central part in the triplet states, and $1.60 \times 10^{-13}$ cm for the non-central part in the triplet states. The constants for the singlet potential are taken to fit the p-p scattering and the low-energy n-p scattering. The constants for the triplet potential are determined by the interaction method to fit the binding energy, the electric quadrupole moment and the magnetic moment of the deuteron. The low-energy scattering total cross sections obtained are in agreement with the experimental values, but the high-energy (83 Mev) total cross sections are large as usual, viz., for symmetrical interaction it is $14.6 \times 10^{-26}$ $cm^2$ and, for interaction in the even states only, it is $12.1 \times 10^{-26}$ $cm^2$. (cf. NSA 4-748). 12 references. (auth)

1259

ANGULAR DISTRIBUTION OF γ-RADIATION FOLLOWING A DEUTERON STRIPPING REACTION. G. R. Satchelor and J. A. Spiers. Proc. Phys. Soc. (London) A65, 980-2(1952) Dec.

Expressions are derived theoretically for the angular distribution of γ radiation from a deuteron stripping reaction measured in coincidence with a fixed direction of the emitted particle. (auth)

1260

COHERENT SCATTERING OF GAMMA-RAYS BY BOUND ELECTRONS. G. E. Brown and J. B. Woodward. Proc. Phys. Soc. (London) A65, 977-80(1952) Dec.

The coherent scattering of high-energy gamma rays by bound electrons in light atoms is investigated. The bound intermediate states of the electron are expanded in terms of free states and potential scatterings. It is found that not only the zero-order term of this expansion, but also the first-order term, must be kept, and that the latter is actually the larger of the two for large-momentum transfer. (auth)

1261

ON JASTROW'S INTERACTION AND THE ELASTIC SCATTERING OF HIGH ENERGY PROTONS BY DEUTERONS. B. H. Bransden. Proc. Phys. Soc. (London) A65, 972-7 (1952) Dec.

An approximate method has been used to calculate the elastic total and differential cross sections for p-d scattering, at incident-proton energies of 150 and 240 Mev. A nuclear interaction has been assumed, of a type suggested by Jastrow, containing an infinite repulsive core in singlet two-body states. Of the various phenomenological interactions, this agrees about the best with the high-energy n-p and p-p scattering data. The calculated angular distribution near 90°, in the c.m. system, is found to be of the right order of magnitude, but agreement with experiment in the forward and backward directions is poor. An explanation of this result is suggested. 13 references. (auth)

1262

THE RADIATIVE CAPTURE OF PROTONS IN FLUORINE. G. A. Jones and D. H. Wilkinson. Proc. Phys. Soc. (London) A65, 1055(1952) Dec.

By measuring the low-energy γ rays produced in the cascade, it was verified that in the radiative capture of protons by F the transition takes place to the first excited state of $Ne^{20}$. Two NaI(Tl) crystals in coincidence examined a thick target of $CaF_2$ bombarded by 700-kev protons; the pulse from one crystal was recorded when the other crystal indicated the emission of a γ ray of energy ~7.5 Mev. The coincidence rate indicates that the cascade is the principal mode of decay and that direct capture to the ground state is rare. (L.M.T.)

1263

POLARIZATION OF THE $O^{16}$ GAMMA-RAYS. L. W. Fagg and S. S. Hanna. Phys. Rev. 88, 1205-6(1952) Dec. 1.

Polarizations of the 6.13-, 6.9-, and 7.1-Mev γ rays from the $F^{19}(p,\alpha\gamma)O^{16}$ reaction have been observed in 400-μ Ilford C-2 emulsions with ~0.12 g/$cm^2$ of $D_2O$ added, when the plates were placed about 4 cm from the thin F target with the plane of the emulsion perpendicular to γ rays emitted at 90°. The reaction employed for polarization detection is the $H^2(\gamma,p)n$ reaction. After exposure, the plates were microscopically scanned and the direction and projected range of each photoproton measured. The γ rays are polarized relative to the proton beam, and the ratio of the 6.13-Mev γ yield to the unresolved 6.9- and 7.1-Mev γ yields is 2.9 ± 0.4 which is in good agreement with other investigations. (L.M.T.)

1264

COULOMB EFFECTS IN PION SCATTERING BY PROTONS UNDER THE CHARGE INDEPENDENCE HYPOTHESIS. Léon Van Hove. Phys. Rev. 88, 1358-60(1952) Dec. 15.

The differential cross sections for scattering of charged π mesons by protons, observed so far at energies and angles for which coulomb effects are negligible, were found compatible with the assumption of charge independence for the nuclear interaction between pion and nucleon. For the

future discussion of scattering experiments now being performed at lower energies, the coulomb effects are calculated, retaining the charge-independence hypothesis for the nuclear part of the interaction and describing it by the phase shifts used in the higher-energy region. For 35-Mev pions, an estimate based on the known magnitude of the total $\pi^+ - p$ cross section shows the coulomb effects to reach 50 percent for a scattering angle of the order of 50° in the c.m. system. (auth)

1265

LOWER LIMITS FOR INTERACTION TIMES IN PHOTON SCATTERING PROCESSES. E. Gora. Phys. Rev. 88, 1212-13(1952) Dec. 1.

Mathematical treatment is given the use of switching-on functions in quantum theory. The results confirm the semi-classical conclusions of Gora (Phys. Rev. 84, 1119(1951)), that for the scattering of light by charged particles a consistent formulation was possible only if the "interaction time" exceeded a lower limit. (L.M.T.)

1266

ANGULAR DISTRIBUTION OF NEUTRONS OF THE D-D REACTION. Paul Baker, Jr. and Arthur Waltner. Phys. Rev. 88, 1213-14(1952) Dec. 1.

The angular distribution of the neutrons from the $H^2(d,n)He^3$ reaction was measured by using 50-kev incident deuterons and positioning 7 Ilford C-2 nuclear plates with emulsions 100 $\mu$ thick at angles of 15, 30, 75, 90, 105, 120, and 135° with the deuteron beam. The plates were exposed to the neutron flux for 40 hr and only those tracks of 40 $\mu$ or greater were counted, thereby discriminating against recoil-proton tracks caused by neutrons scattered by surrounding materials. From the results it appears that the photographic method is in agreement with other methods of measuring neutron angular distributions. (L.M.T.)

1267

THE STOPPING POWER OF K-ELECTRONS. M. C. Walske. Phys. Rev. 88, 1283-9(1952) Dec. 15.

The stopping power of K-shell electrons for large incident-particle energies is calculated in this paper, adding to and correcting previous work on the subject. A definition is given for the average ionization potential of an atom independent of the energy of the incident particle. An integral representation is derived for Bethe's term $C_K$ which corrects the simple K-shell stopping-number expression. Finally, asymptotic formulas, applicable at large incident-particle energies, are given for use with any element. (auth)

1268

ATOMIC ELECTRON EJECTION IN LARGE-ANGLE SCATTERING. M. E. Ebel and W. F. Fry. Phys. Rev. 88, 1306-8(1952) Dec. 15.

It is found that an electron in the kev range frequently accompanies the large-angle scattering of $\mu$ mesons, $\pi$ mesons, and protons in photographic emulsions. For $\mu$ mesons of energy between 1.6 and 4.1 Mev which are scattered through angles greater than 28°, there is observed an electron of energy greater than 10 kev in 21 ± 6 percent of the scatterings. The electron-energy distribution seems to follow an inverse 7/2 power law. These electrons are interpreted as being ejected as the result of the direct coulomb action of the incident particle on the electrons of the scattering atom. The high probability of ejection arises from the fact than an incident particle which undergoes a large-angle scattering always passes through the region of greatest electron density. The probability of ejection is calculated from second-order perturbation theory using approximations valid at high energies. Although the approximations limit the usefulness of the result, the assumed mechanism seems adequate for the description of the phenomenon. (auth)

1269

PROTON-DEUTERON SCATTERING AT 5.1 MEV AND DEUTERON-PROTON SCATTERING AT 10.2 MEV. K. B. Mather. Phys. Rev. 88, 1408-11(1952) Dec. 15.

A photographic scattering chamber has been used to study the elastic scattering of 5.1-Mev protons by deuterium and 10.2-Mev deuterons by hydrogen, these being the same process in the c.m. system. Differential cross sections were obtained from 16.4 to 172.9°. These are in good agreement with other experimental data at about the same energy. Comparison is made with the theoretical angular distribution due to Buckingham, Hubbard, and Massey (Proc. Roy. Soc. (London) A211, 183(1952)), based on a symmetrical-exchange force. Agreement is close at this energy, favoring exchange rather than ordinary-force theories. However, at higher energies (~10-Mev p–d) the BHM calculations do not represent the interaction satisfactorily. (auth)

*RADIATION EFFECTS*

1270

THE EFFECT OF NEUTRON BOMBARDMENT ON THE LOW TEMPERATURE ATOMIC HEAT OF SILICON. P. H. Keesom, K. Lark-Horovitz, and N. Pearlman. Science 116, 630-1(1952) Dec. 5.

The atomic heat of a Si ingot weighing 260 g was measured before and after exposure to $5 \times 10^{18}$ neutrons/cm$^3$. The sample was then annealed at several temperatures up to 780°C, being held at each temperature for various times, then cooled at about 10°C/hr. Its heat capacity below 5°K was measured after each heat treatment. The total atomic heat equation had the form $C_v = \alpha T^3 + \gamma T$, indicating lattice and carrier contributions; numerical values of the constants for the various heat treatments are listed. The results lend further support to the idea that lattice disorder produced by neutron bombardment results in carrier traps in Si which can be healed out by suitable heat treatment. (G.Y.)

1271

ALPHA-RADIATION DAMAGE IN ZIRCON. Patrick M. Hurley and Harold W. Fairbairn. J. Applied Phys. 23, 1408 (1952) Dec.

All natural zircons show some degree of radiation damage from $\alpha$ activity due to small U-crystal inclusions in the zircon. Determination of the total $\alpha$ bombardment by measurement of present $\alpha$ activity and age may be correlated with the amount of damage and provide information on the damage process. It was found that a more accurate measurable criterion of alpha damage to the structure of zircon is the x-ray diffraction angle from the (112) plane. A plot of the zircon diffraction angle from the (112) plane vs. total number of $\alpha$ disintegrations per mg of known samples yields constants that can be utilized in determining the age of unknown samples if homogeneous and not too badly disordered. (L.M.T.)

*RADIOACTIVITY*

1272

Oak Ridge National Lab.

DOSE RATES OF RADIATION FROM THORIUM AND FROM ENRICHED URANIUM, by T. E. Bortner and H. K. Richards. Issued Apr. 9, 1951. Decl. Dec. 22. 1952. 19p. (AECD-3484; ORNL-761)

Dose rates at a plane surface of a thick disk of thorium and of enriched uranium metal were measured with the extrapolation chamber. Using a carbon collector, the total dose rates were found to be, for thorium 7.2 esu/hr/cm$^3$, and for the enriched uranium 1413.5 esu/hr/cm$^3$. The residual radiation (principally beta) with the alpha filtered out was found to be 0.096 esu/hr/cm$^3$ for thorium, and

0.208 esu/hr/cm$^3$ for the enriched uranium. The total dose rate measured in rep/hr, of this sample of enriched uranium is 98.16 times that of natural uranium. Calculations by H. K. Richards gave a ratio of 103.5 for enriched to natural uranium. (auth)

1273

Oak Ridge National Lab.

TABLE OF LOG ft VALUES: OCTOBER 1952, by R. W. King, N. M. Dismuke, and K. Way. Oct. 1952. 26p. (ORNL-1450)

A revision and extension of Feingold's list of log ft values (Revs. Modern Phys. 23, 10(1951)) is presented. The present list is based on data in the files of the Nuclear Data group of the National Bureau of Standards as of October, 1952. The computations drew heavily on the graphs of f published by Feenberg and Trigg (Revs. Modern Phys. 22, 399(1950)). (L.M.T.)

1274

THE ISOMERS OF KRYPTON AND XENON; AN INVESTIGATION WITH ELECTROMAGNETICALLY SEPARATED RADIOACTIVE ISOTOPES. Ingmar Bergström. Arkiv Fysik 5, 191-295(1952).

A systematic investigation of the isomers of krypton and xenon has been performed. The following radioactive isotopes have been investigated: $Kr^{79}$, $Kr^{83m}$, $Kr^{85}$, $Kr^{85m}$, $Xe^{125}$, $I^{125}$, $Xe^{127}$, $Xe^{129m}$, $Xe^{131m}$, $Xe^{133}$, $Xe^{133m}$ and $Xe^{135}$. For the $\beta$-spectrometer and scintillation spectrometer investigations electromagnetically separated radioactive Kr and Xe have been used. Two new isomers of $Xe^{129m}$ and $Xe^{133m}$ have been discovered. The isomerism of $Xe^{131m}$ has been established. $Kr^{83m}$ proved to decay with the emission of two $\gamma$ rays of quite other energies than those earlier accepted. A consistent decay scheme of $Kr^{85m}$ has been constructed. In almost all other cases no $\beta$-spectrometer investigations have been performed earlier because of the great difficulties in preparing gas samples convenient for $\beta$-spectrometer measurements. Because of the ideal character of the separated samples it has been possible to detect and study very low-energy electron lines. Several low-energy $\gamma$ rays not earlier known have thus been discovered. The appearance of the low-energy Auger lines has been used to draw conclusions about the radioactive decay of the isotopes investigated. The experimental results have been compared with the predictions of the jj nuclear shell theory. In the majority of the cases investigated a good agreement with the theoretical predictions was obtained. (auth)

1275

A DETERMINATION OF THE MULTIPOLE CHARACTER OF THE 637 AND 722 KEV. $\gamma$-RAY TRANSITIONS IN $Xe^{131}$. J. L. Wolfson. Can. J. Phys. 30, 715-6(1952) Nov.

Verster et al. (Physica 17, 637(1951)) and more recently D. Rose et al. (Phys. Rev. 86, 863(1952)) reported that the 637-kev $\gamma$-ray transition in $Xe^{131}$ following decay of $I^{131}$ is E1 in character on the basis of its measured K-conversion coefficient. However, Bell and Graham (Phys. Rev. 86, 212 (1952)), also on the basis of K-conversion coefficient, found that the radiation is E2 in character. The results of an experiment performed to resolve these discrepancies are reported and support the conclusions of Bell and Graham. It is found that both the 637- and 722-kev $\gamma$ rays are predominantly E2 with perhaps some admixture of M1 characteristics. (L.T.W.)

1276

PRECISION MEASUREMENTS OF NUCLEAR GAMMA-RADIATION BY TECHNIQUES OF BETA-SPECTROSCOPY. PART III. MEASUREMENTS OF GAMMA-RAYS FROM LANTHANUM$^{140}$, SODIUM$^{24}$, ThC'' AND GALLIUM$^{72}$. Arne Hedgran and David Lind. Arkiv Fysik 5, 178-90(1952).

An experiment was performed to check the linearity of the spectrometer by measuring three $La^{140}$ $\gamma$ rays, of which one should equal the sum of the other two. Within the experimental error of 3 in $10^4$ no deviation was found in the region 0.2 to 0.7 Mev. The energies of the two $Na^{24}$ $\gamma$ rays were measured to be 1.3680 ± 0.0010 and 2.5735 ± 0.0010 Mev. A series of measurements were performed to utilize a new absolute momentum determination to settle the uncertainty regarding the energy of annihilation radiation. The annihilation energy derived in this way agrees with the assumption of equal positron and electron masses and it was concluded that the standard used previously was in error. A measurement was performed of the close 2.5-Mev $\gamma$-ray doublet of $Ga^{72}$. (auth)

1277

BETA-GAMMA ANGULAR CORRELATION FOR HEAVY NUCLEI. A. Z. Dolginov. Zhur. Eksptl'. i Teoret. Fiz. 22, 668-76(1952) June. (In Russian)

The effect of the nuclear coulomb field on angular correlation between $\beta$ particle and subsequent $\gamma$ quantum is discussed. It is shown that for forbidden $\beta$ transitions at $Z > A^{1/3}E_0$ the nuclear coulomb field substantially affects the $\beta$-$\gamma$ angular correlation. Expressions are found for the first-forbidden transition, correct for any Z for any multipolarity of the subsequent quantum.

1278

RADIATIONS FROM $Zr^{97}$ AND $Nb^{97}$. C. E. Mandeville, E. Shapiro, R. I. Mendenhall, E. R. Zucker, and G. L. Conklin. J. Franklin Inst. 381-9(1952) Nov.

$Zr^{96}O_2$ (isotopic concentration 90 per cent) was irradiated by slow neutrons in the Oak Ridge pile. The half period of the niobium daughter element, chemically separated from zirconium, was found to be 72.1 ± 0.7 min and that of $Zr^{97}$ to be 17.0 ± 0.2 hr. By aluminum absorption and Feather analysis, maximum beta-ray energies of 2.50 and 1.40 Mev were measured for parent and daughter element, respectively. Lead absorption of the quantum radiations of the equilibrium mixture indicated a gamma ray at 0.74 Mev as well as a softer component. Coincidence absorption yielded a maximum gamma ray energy of 1.42 Mev. The beta-gamma coincidence rate of $Nb^{97}$ was constant, independent of the beta-ray energy and of such magnitude as to suggest that each beta ray is followed on the average by 0.7 Mev of gamma-ray energy. The beta-gamma coincidence rate of the equilibrium mixture showed that the hard beta rays of $Zr^{97}$ proceed directly to the metastable state of $Nb^{97}$. Very few beta rays of $Zr^{97}$ are in immediate coincidence with any gamma radiation. (auth)

1279

ANGULAR DISTRIBUTION OF BETA PARTICLES DURING BETA DECAY OF HEAVY NUCLEI. A. Z. Dolginov. Zhur. Eksptl'. i Teoret. Fiz. 22, 658-67(1952) June. (In Russian)

The effect of the coulomb field on angular correlation between $\beta$ particle and neutrino is discussed. Relativistic wave functions of the electron in a coulomb field are used for computation. The field within the nucleus is considered constant. It is shown that the effect of the coulomb field should not be neglected in the case of forbidden $\beta$ transitions. The author compares his work with that of Greuling and Meeks (Phys. Rev. 82, 531(1951)).

1280

DISINTEGRATION SCHEME OF $Fe^{59}$. Franz R. Metzger. Phys. Rev. 88, 1360-7(1952) Dec. 15.

The radiations accompanying the disintegration of $Fe^{59}$ have been investigated using lens-spectrometer and scintillation-counter techniques. Three beta-ray spectra of end points 1560 ± 8 kev (0.3%), 462 ± 3 kev (53.9%), and 271 ± 3 kev (45.8%) lead to the ground state, to 1098- and 1289-kev excited states of $Co^{59}$. The 1560-kev spectrum has a for-

bidden shape; the shapes of the other partial spectra are allowed. Gamma rays of 191 ± 2 kev (2.8%), 1098 ± 6 kev (56.7%) and 1289 ± 6 kev (43%) represent all the transitions possible between the three $Co^{59}$ states. The conversion coefficients characterize the 191- and 1098-kev transitions as magnetic dipoles, the 1289-kev transition as electric quadrupole. A disintegration scheme is presented in which spins and parities are assigned to all the levels involved. The single-particle orbitals corresponding to the assigned spins and parities agree with those of the spin-orbit-coupling shell model. Accordingly, the first excited state (1098 kev) of $Co^{59}$ is an $f_{\frac{5}{2}}$ state, and its 1098-kev energy difference from the $f_{\frac{7}{2}}$ ground state represents the spin-orbit splitting of the f-levels, which is responsible for the existence of a closed shell at N or Z = 28. The angular correlation of the 191 kev-1098 kev gamma-gamma cascade was measured and found to support the proposed spin assignment. 16 references. (auth)

1281

THE EVIDENCE OF THE ONCE-FORBIDDEN SPECTRA FOR THE LAW OF $\beta$ -DECAY. H. M. Mahmoud and E. J. Konopinski. Phys. Rev. 88, 1266-75(1952) Dec. 15.

A series of empirical arguments has developed which leave two alternatives for the law of $\beta$ interaction: an STP (scalar + tensor pseudoscalar) or a VTP ( V ≡ vector) combination. We offer a new argument, based on an interpretation of the reported "allowed" shapes of once-forbidden spectra, which favors the STP over the VTP form. This new development may be important because it is a possible last step in arriving at a unique law of $\beta$ decay (i.e., all three components of the STP form would become both admissible and necessary). A critical stage in the new argument is the explanation of the "allowed" shapes. The theory may yield such shapes if the coulomb potential energy at the nucleus is sufficiently larger than the kinetic energy with which electron and neutrino are emitted. That condition happens to be best fulfilled just for the cases in which the "allowed" shapes are the most accurately observed. However, the dominance of the coulomb effect cannot be a sufficient condition except with the STP or VA forms of $\beta$ interaction. Other forms make deviations from the allowed shape possible even when the coulomb energy is supposed indefinitely large. The last type of deviation has the same origin as the well-known Fierz interference in allowed spectra. The absence of the latter effect has been widely quoted but apparently never heretofore examined in detail. It is important in one of the series of arguments mentioned above. Hence, we investigate the empirical limits on Fierz-type deviations not only in once-forbidden but also in allowed spectra. 27 references. (auth)

1282

THE DISINTEGRATION SCHEME OF $V^{48}$. Paul L. Roggenkamp, Charles H. Pruett, and Roger G. Wilkinson. Phys. Rev. 88, 1262-5(1952) Dec. 15.

The disintegration scheme involved in the decay of 16-day $V^{48}$ to $Ti^{48}$ has been established by scintillation studies, and spins and parities have been assigned to the levels. The angular correlation of the well-known cascade gamma-ray pair with energies of 0.99 and 1.32 Mev has been measured. The corresponding levels are found to have spins 0–2–4. The positron spectrum has been measured with a magnetic beta-ray spectrometer and shows evidence for positron emission to a level in $Ti^{48}$, 22.2 Mev above the ground state. The positron group involved in the decay to the 2.31-Mev level of $Ti^{48}$ is found to have an end point of 0.69 Mev. 11 references. (auth)

*RARE EARTHS AND RARE-EARTH COMPOUNDS*

1283

THE $M_{IV}$ AND $M_V$ ABSORPTION EDGES OF $^{59}Pr$, $^{60}Nd$, $^{62}Sm$ AND $^{63}Eu$. H. F. Zandy. Proc. Phys. Soc. (London) A65, 1015-22(1952) Dec.

Investigations on the $M_{IV}$ and $M_V$ absorption edges of four of the light rare-earth elements are described, using a bent-crystal focusing spectrometer. In particular, close attention has been paid to the occurrence of fine structure (white lines) on the long wavelength side of the edge. Such white lines are found at both edges for $Pr^{59}$, $Nd^{60}$, and $Sm^{62}$, but for $Eu^{63}$, while a white line is found at the $M_V$ edge, it is absent or very weak at the $M_{IV}$ edge. 12 references. (auth)

*SHIELDING*

1284

BARITE-AGGREGATE CONCRETE FOR GAMMA-RAY SHIELDING. K. A. Shelstad, V. E. Vaughan, and E. L. Cameron. Can. J. Technol. 30, 334-9(1952) Dec.

Data concerning the preparation, physical properties, and gamma-ray attenuation of concretes prepared using barite as aggregate are reported. Concrete of density from 190 to 200 $lb/ft^3$ is readily obtainable. Mechanical strength is limited by the friable nature of the aggregate rather than by the strength of the barite-cement bond, as indicated by visual observation of fractured specimens. Subject to this limitation, there are no inherent difficulties in using barite as aggregate. Cement-aggregate bond is good and water-cement ratio is normal. Deterioration with time was not studied. Attenuation of gamma rays (1.1 to 1.3 Mev) under narrow-beam conditions can be predicted from a knowledge of the concrete density and using a mass absorption coefficient of 3.9 $in.^2/lb$. (auth)

*SPECTROSCOPY*

1285

Spectroscopy Lab., Illinois Inst. of Tech.

SUBSTITUTED METHANES. XIII. INFRARED SPECTRAL DATA AND ASSIGNMENTS FOR DIBROMODIFLUOROMETHANE; TECHNICAL REPORT NO. 9 ON MOLECULAR SPECTROSCOPY, MOLECULAR STRUCTURE AND THERMODYNAMICS [FOR] SEPTEMBER 15, 1951 TO SEPTEMBER 14, 1952, by Charlotte E. Decker, Forrest F. Cleveland, and Richard B. Bernstein. Nov. 18, 1952. 4p. (NP-4201; Technical Report No. 9; U25128)

Infrared spectral data were obtained for gaseous $CBr_2F_2$ in the region 400 to 4000 $cm^{-1}$ using a Perkin-Elmer model 21 double-beam spectrophotometer with NaCl optics and a Beckman IR-2 spectrometer with KBr optics. The observed wave numbers, estimated relative intensities, and assignments are listed. (TID-LC)

1286

Spectroscopy Lab., Ill. Inst. of Tech.

SUBSTITUTED METHANES. XII. INFRARED SPECTRAL DATA FOR DEUTEROTRICHLOROMETHANE; TECHNICAL REPORT NO. 8 ON MOLECULAR SPECTROSCOPY, MOLECULAR STRUCTURE AND THERMODYNAMICS [FOR] SEPTEMBER 15, 1951 TO SEPTEMBER 14, 1952, by Richard B. Bernstein, Adon A. Gordus, and Forrest F. Cleveland. Nov. 18, 1952. 3p. (NP-4202; Technical Report No. 8)

The report summarizes recent data on a sample of $CCl_3D$ containing approximately 1% $CCl_3H$. A Perkin-Elmer Model 21 Double-beam Spectrophotometer with NaCl optics was used, making possible the detection of weak bands in the spectral regions normally obscured by atmospheric absorption. (auth)

1287

Naval Radiological Defense Lab.

MEASUREMENT OF THE SPECTRAL INTENSITY DISTRIBUTION OF A CONVERGENT HIGH-INTENSITY LIGHT BEAM WITH A MAGNESIUM OXIDE-SMOKED PLATE, by F. W. Brown, III. July 21, 1952. 16p. (USNRDL-367)

The absolute spectral intensity distribution at the center of the focused image of a carbon arc was determined in the region 3000 to 9000 A. The basic optical system (used in studies of thermal radiation damage) consisted of a high-

intensity carbon arc at the focus of a 36-in. paraboloidal searchlight mirror, and a similar condensing mirror which focused the reflected beam in a cone of vertex angle 120°. The intensity at the focus of the condensing mirror was 100 cal/cm²/sec. The high intensity and convergence of the beam at the focus led to the adoption of a new technique for the spectral analysis. A magnesium oxide-smoked plate was inserted into the beam at the focus, and the light reflected normally from the plate was focused upon the slit of a spectrograph. Absolute intensities were obtained by comparison with a standard pyrometric arc. The results are compared with absolute black-body measurements of the total intensity at the focus. The observed differences in spectrum between arc and image are discussed. (auth)

1288

MASS OF $K^{40}$. Walter H. Johnson, Jr. Phys. Rev. 88, 1213(1952) Dec. 1.

The masses of $K^{40}$, $Ca^{40}$, and $A^{40}$ measured by means of a double-focusing mass spectrometer confirmed recent conclusions that $K^{40}$ decayed to $Ca^{40}$ by $\beta$ decay and to $A^{40}$ by a K capture followed by a $\gamma$ emission. An enriched sample of $K^{40}$(7.74%) was used as an ion source and $(C^{12})_2O^{16}$ was used as a comparison peak. A run consisted of 8 $C_2O$-$A^{40}$ traces, 10 $C_2O$-$K^{40}$ traces, and then 8 more $C_2O$-$A^{40}$ traces to determine the mass difference of the $K^{40}$-$A^{40}$ doublet. The $K^{40}$-$Ca^{40}$ doublet was determined similarly. The masses determined for $K^{40}$, $Ca^{40}$, and $A^{40}$ were 39.97654, 39.975127, and 39.974940 amu, respectively. (L.M.T.)

*THEORETICAL PHYSICS*

1289

VACUUM POLARISATION BY SPIN ONE PARTICLES. James McConnell. Progress Theoret. Phys. (Japan) 7, 421-2(1952) Apr.

Divergent integrals in the self-charge problem are derived from vacuum polarization by the virtual production of meson pairs with spin one. It is concluded that the theory of vacuum polarization by spin-one mesons contains ambiguities which cannot be obviated except by some new postulates. The postulate that principle values of divergent integrals are to be taken in all cases has the physical basis that a purely imaginary term in the self-charge expressions is excluded. It also reduces the degree of divergence to a logarithmic one. This in turn may be compensated by self-charge contributions from the current induced in the vacuum by virtual pair production of particles with spin zero or ½. (L.T.W.)

1290

APPLICATION OF FOK'S FUNCTIONAL METHOD TO THE SELF-ENERGY PROBLEM. Yu. V. Novozhilov. Zhur. Eksptl'. i Teoret. Fiz. 22, 264-75(1952) Mar. (In Russian)

Fok's method is used to derive Dirac's equations containing electromagnetic mass and radiational corrections. The presented derivation is simpler than conclusions based on application of perturbation theory in the method of secondary quantization of electron and radiation fields.

1291

TRANSFORMATION LAWS OF SPINORS WHICH ARE SOLUTIONS OF DIRAC'S EQUATIONS. I. S. Shapiro. Zhur. Eksptl'. i Teoret. Fiz. 22, 524-30(1952) May. (In Russian)

Taking into account the temporary reflections, the author shows that for particles with spin ½ and rest-mass not zero, four nonequivalent types of spinors satisfying Dirac's equations exist. The nonequivalent types of Dirac's spinors with rest-mass zero, their number amounting to 14, are outlined. Problems of so-called conjugated spinors and transformational properties of wave functions of particles with whole spin number are analyzed.

1292

ON THE STRUCTURE OF THE INTERACTION OF THE ELEMENTARY PARTICLES. I. THE RENORMALIZABILITY OF THE INTERACTIONS. Shoichi Sakata, Hiroomi Umezawa, and Susumu Kamefuchi. Progress Theoret. Phys. (Japan) 7, 377-89(1952) Apr.

The applicability of the renormalization theory was investigated for the general types of local interactions. It was found that the interaction having the coupling constant of dimensions $L\eta$ could be renormalized if the conditions $\eta \leq 0$ were valid. It is remarkable that this condition is closely related to Heisenberg's classification of the interactions. (auth)

1293

THE ANGULAR DISTRIBUTION OF SCATTERING AND REACTION CROSS SECTIONS. John M. Blatt and L. C. Biedenharn. Revs. Modern Phys. 24, 258-72(1952) Oct.

The general formula for the angular distribution in collisions between pairs of particles is simplified by performing explicitly all sums over magnetic quantum numbers. The resulting expressions involve coefficients introduced by Racah for the study of complex atomic spectra. The cross sections are expressed as series in Legendre polynomials, each coefficient in the series being manifestly real. The general theory is then specialized for the case of nuclear reactions and scattering associated with one isolated resonance level of the compound nucleus. Formulas are derived for the various differential reaction cross sections and for scattering with and without change of channel spin. The interference terms between resonance and potential scattering are written explicitly, both for neutral and for charged particles. (auth)

1294

BOUND-STATE PERTURBATION THEORY IN FOUR-DIMENSIONAL MOMENTUM REPRESENTATION. G. E. Brown. Proc. Roy. Soc. (London) A215, 371-85(1952) Dec. 5.

A four-dimensional perturbation theory for bound-state problems is developed here. It is shown that modified S-matrix techniques and graphical methods can be applied to bound-state problems. The correspondence of this theory to the ordinary perturbation theory is discussed, and by way of illustration, the four-dimensional theory is applied to the calculation of energy corrections from the exchange of two transverse photons by the electron and proton in hydrogen. This exchange is found to contribute only to the fine structure and not to the spin-spin interaction in the first order it enters, $\alpha^3(m/M)R$. 10 references. (auth)

1295

BOUNDARY CONDITIONS IN THE MECHANICS OF FIELDS. S. M. Neamtan and E. Vogt. Can. J. Phys. 30, 684-98(1952) Nov.

A variational principle has been set up for the description of relativistic fields with the aid of lagrangians involving second order derivatives of the field functions. This constitutes a generalization of the usual formulation in that, besides the boundary conditions usually imposed, it admits also linear homogeneous boundary conditions. The formulation has been developed for the complex scalar and complex vector fields. The variational principle then yields not only the wave equations but also the allowed boundary conditions. The formulation has been developed for the complex scalar and complex vector fields. The variational principle then yields not only the wave equations but also the allowed boundary conditions. A hamiltonian and equations of motion in canonical form can be set up. A symmetric stress-energy tensor and a charge-current vector are defined, yielding the usual conservation equations. For the vector field, $\pi_4$ is not identically zero; also the Lorentz condition arises out of the variational principle and does not have to be separately imposed. For the Dirac field an extension to lagrangians with second order derivatives is not possible, but for this field also the variational principle yields the allowed boundary conditions. (auth)

1296
OPERATOR CALCULUS IN QUANTIZED FIELD THEORY. Kazuo Yamazaki. Progress Theoret. Phys. (Japan) 7, 449-68(1952) May.

Following the suggestion of Feynman, we analyze the operators corresponding to the electron-positron field by means of the operator calculus. Thus we can deduce operationally Feynman's theory from the second quantized theory. With the aid of the external spinors, which are considered as the analogs of Schwinger's prescribed source, we obtain formally a closed form of the S matrix. Using this result we can derive the diffusion equation for the Dirac field very simply. The relations with Schwinger's new theory of the Green function are also discussed. Finally the formula for multiple-boson or fermion pair production are presented as illustrations for applications. 13 references. (auth)

1297
ON A RELATIVISTIC INTEGRAL EQUATION FOR BOUND STATES. Chushiro Hayashi and Yasuo Munakata. Progress Theoret. Phys. (Japan) 7, 481-516(1952) May.

Bound states of two particles are described relativistically by a homogeneous integral equation. Its general properties and reduction to the non-relativistic equation are studied. In the case of scalar particles with scalar-photon interaction, if we take the ladder approximation and omit the $D^{(1)}$ part of the $\delta_+$ function, energy levels are obtained relativistically as explicit functions of the fine-structure constant. Difficulties which are met in the case of two spinor particles are discussed. 16 references. (auth)

1298
THE MASS VARIATION WITH VELOCITY IN THE BOPP'S UNITARY FIELD THEORY. II. Masao Sugawara and Sakae Minami. Progress Theoret. Phys. (Japan) 7, 563-72(1952) June.

In the Bopp-type non-local field theory the total energy and momentum of the field are calculated, starting from the expression for the energy and momentum tensor recently derived by Y. Ōno (Progress Theoret. Phys. (Japan) 6, 925 (1951)), and it is shown that the result is the same as that obtained in the previous paper on the same subject, starting from the energy and momentum tensor derived by Bopp. Therefore nothing is modified in the condition to ensure the four-vector variation of the total energy and momentum of the field, namely the condition for vanishment of self-stress. Further it is shown that the two expresssions for the energy and momentum tensor are essentially equivalent to each other. As an interesting example, the authors examine a non-local field theory proposed by Pais and Uhlenbeck (Phys. Rev. 79, 145(1950)) and show that the condition for the vanishment of the self-stress and the regulator condition for the finiteness of the self-energy are satisfied simultaneously in this case. (auth)

1299
ON THE STRUCTURE OF THE INTERACTION OF THE ELEMENTARY PARTICLES. II. DOES THE INTERACTION OF THE SECOND KIND EXIST IN NATURE? Hiroomi Umezawa. Progress Theoret. Phys. (Japan) 7, 551-62(1952) June.

As was shown in the previous paper (Progress Theoret. Phys. (Japan) 7, 377(1952)), it would have a very important meaning for the formation of the future theory of elementary particles to decide whether there are interactions of the second kind in nature. In this paper, the author looks first for those types of fields which may have interactions of the first kind, and then discusses whether the model of the mesons can be explained by means of these fields with interaction of the first kind only. 19 references. (auth)

1300
RADIATIVE CORRECTIONS IN QUANTUM ELECTRODYNAMICS. I AND II. A. D. Galanin. Zhur. Eksptl'. i Teoret. Fiz. 22, 448-70(1952) Apr. (In Russian)

It is shown that, taking Heisenberg's equations as point of departure, operators can be obtained for radiative corrections in a desired approximation expressed in a series of powers of $e^2/hc$. Rules for derivation of matrix elements agree with those obtained in previous work by the author (NSA 6-455). The method is generalized for cases where real photons are present and for problems of multiple electrons.

1301
ACTION AS A SPACE COORDINATE. VI. Yu. B. Rumer. Zhur. Eksptl'. i Teoret. Fiz. 22, 742-54(1952) June. (In Russian)

The relation of 5-optics to the relativistic theory of elementary particles with integral spin is explained.

1302
REMARK ON THE SELF ENERGY PROBLEM OF THE PHOTON. O. Hara and H. Shimazu. Progress Theoret. Phys. (Japan) 7, 591-2(1952) May-June.

The Lorentz transformation is re-examined in treating the problem of the divergence of the self-energy of the photon. Specifically, the example considered is the interaction of the electromagnetic field with the electron field. (L.M.T.)

1303
ON THE EQUIVALENCE PRINCIPLE. T. Dodo and R. Utiyama. Progress Theoret. Phys. (Japan) 7, 589-91(1952) May-June.

The equivalence of the scalar (pseudoscalar) and vector (pseudovector) couplings of the meson and nucleon fields is shown by means of a change of variables in the lagrangian. It is also shown that this modification of the lagrangian is equivalent to a unitary transformation of the hamiltonian. (auth)

1304
AN EMPIRICAL MASS SPECTRUM OF ELEMENTARY PARTICLES. Y. Nambu. Progress Theoret. Phys. (Japan) 7, 595-6(1952) May-June.

An empirical mass spectrum is presented in terms of 137 $m_e$, $\frac{1}{2}$ the mass of the $\pi$ meson, for elementary particles. The "mass number" of the observed particles is either integer or half-odd, this being valid within a deviation of ~15 $m_e$, or ~0.1 mass unit, for those cases in which the experimental error is also of this order of magnitude. Other observations of the results are: (1) the adopted mass unit incidentally agrees with Heinsenberg's natural unit and (2) bosons seem to have integral, and fermions, half-integral, mass numbers. (L.M.T.)

1305
ON THE NEW DESCRIPTION OF QUANTUM-MECHANICS. H. Shimooda. Progress Theoret. Phys. (Japan) 7, 597-99 (1952) May-June.

The idea of "continuous observation" is introduced into the "particle path" of Feynman's quantum theory. Taking the path as a physical quantity (a quantity measured by the "continuous observation") a sort of accidental uncertainty enters into the conventional quantum-mechanical description. This new probability amplitude may be one of random choice of position, because a particle continuously chooses any path. Then for the probability amplitude specified by the position of the particle, the probability amplitude of random choice of position must be taken into account. (L.M.T.)

1306
EXCITED STATES OF ELEMENTARY PARTICLE AND THE QUANTIZATION OF ELEMENTARY PARTICLES. M. Sugawara. Progress Theoret. Phys. (Japan) 7, 599-601 (1952) May-June.

There is strong evidence that a $V^0$ particle decays as follows: (1) $V^0 \rightarrow p + \pi^- + \pi^0$ or (2) $V^0 \rightarrow n + \pi^+ + \pi^-$. If this is true, then the two $V^0$ particles turn out to be the same kind of particle. In the light of this, the $V^0$ particle is proposed to be nothing but an excited state of a nucleon, which

comes as a consequence of a new kind of quantization of a nucleon surrounded by the $\pi$-meson field. Further assumption is made that a $\mu$ meson is an excited state of an electron or a neutrino. (L.M.T.)

1307

INVARIANT CONSTRUCTION OF THE FIELD QUANTUM THEORY. II. V. L. Bonch-Bruyevich and B. V. Medvedev. Zhur. Eksptl'. i Teoret. Fiz. 22, 425-35(1952) Apr. (In Russian)

By means of a construction previously developed by N. N. Bogolyubov and the authors, the internal contradiction of localized variants of quantum-relativistically invariant theory of arbitrarily interacting scalar field is proved.

1308

ON FIELD THEORIES WITH NON-LOCALIZED INTERACTION. Calude Bloch. Kgl. Danske Videnskab. Selskab, Mat. fys. Medd. 27, Paper No. 8(1952). 55p. (In English)

A relativistic field theory with non-localized interaction is investigated. The field equations are deduced by the variational principle from a Lagrange function containing an interaction term involving a form function. The essential departure from conventional field theory is the lack of causality, or in other words, the lack of propagation character of the field equations. It is shown, however, that under certain conditions which must be satisfied by the form function this property remains limited to small domains. Similarly there are no continuity equations, but conservation laws hold in the large. The quantization is performed according to an extension of the scheme developed by Yang and Feldman making use of the concept of incoming and outgoing fields. It is shown that this procedure is always consistent with the field equations. Assuming that the field equations can be solved by means of power-series expansions it is possible to give rules generalizing Feynman's rules giving all the terms of the expansion of an outgoing operator in terms of the incoming operators. Every term is associated with a doubled graph. An investigation is made of the convergence of the integrals obtained in this way. It is shown that many terms converge automatically as soon as the Fourier transform of the form function is supposed to fall off rapidly at large momenta. Some divergences remain in the higher-order terms. They can, however, be removed by assuming that the Fourier transform of the form function has only time-like components. It is finally shown that the gage invariance requires the addition of a new interaction term in the Lagrange function, corresponding to a sort of exchange current. (auth)

1309

THE SECOND VIRIAL COEFFICIENT NEAR ABSOLUTE ZERO. H. S. Green. Proc. Phys. Soc. (London) A65, 1022-9(1952) Dec.

By the solution of Bloch's equation for the density matrix, a development is obtained suitable for the exact evaluation of the second virial coefficient near absolute zero. Assuming a molecular interaction of the Lennard-Jones type (Proc. Roy. Soc. (London) A106, 463(1924)), it is shown that the virial coefficient for helium is $-\{\frac{1}{2}(\pi\beta)^{\frac{3}{2}} + 31.15\,\pi\beta + O(1)\}A^3$, $\pi\beta = 38.04/T$. General formulae are given for fluids the molecules of which satisfy Bose or Fermi statistics. 15 references. (auth)

1310

MOBILITY IN HIGH ELECTRIC FIELDS. E. M. Conwell. Phys. Rev. 88, 1379-80(1952) Dec. 15.

An extension of conductivity theory to high fields, subject to the usual simplifying assumptions, is carried out for the cases in which the change of energy of an electron in a collision can be neglected. This yields a relationship between mobility and relaxation time which is valid over a wide range of fields. (auth)

1311

BOUND STATES AND THE INTERACTION REPRESENTATION. S. T. Ma. Phys. Rev. 88, 1211(1952) Dec. 1.

The temporal development of the state vectors of the free and bound states was derived from the time-independent formulation of quantum theory (Ma, Phys. Rev. 87, 652(1952); NSA 6-5709). This note clarifies the inconsistency that developed as to whether the transformation operator $W_+(t)$ is unitary or non-unitary. (L.M.T.)

1312

PROPAGATION IN ELECTRON-ION STREAMS. R. Q. Twiss. Phys. Rev. 88, 1392-1407(1952) Dec. 15.

A mathematical theory is given for the propagation of electromagnetic waves in electron-ion streams composed of N discrete beams. The solution, which is fully relativistic, is obtained in vector form by an extension of Hansen's theory (Phys. Rev. 47, 139(1935)), and takes explicit account of the initial and boundary conditions. When certain restrictions are placed upon the transverse boundary conditions the general solution satisfying arbitrary initial conditions can be expanded in terms of a complete orthogonal set of elementary vector solutions. For this case the necessary and sufficient conditions are found for amplification and instability both in the terminated and the unterminated stream. The correct physical interpretation of the conventional "Ansatz" solutions is found together with the conditions under which they are valid. One is then able to distinguish amplified growing waves from reverse waves attenuated in the reverse direction. Finally the analysis is extended to the continuous-velocity distribution. It is shown that the present treatment differs significantly from Landau's theory (J. Phys. (U.S.S.R.) 10, 25(1946)) for the thermal plasma and the consequences of this are discussed. 18 references. (auth)

1313

GRAVITATION AND ELECTRODYNAMICS. Behram Kursunoğlu. Phys. Rev. 88, 1369-79(1952) Dec. 15.

In this paper Einstein's unified field theory is modified, and some of the physical implications of the new theory are examined. It entails: (1) a restriction of 4-current distribution, (2) an electromagnetic field consisting of short- and long-range parts, (3) a finite self-energy for the electron, (4) a classical description of pair production and annihilation as discussed by Feynman in his electrodynamics, (5) the Lorentz-force law for a charged particle moving in an external electromagnetic field, (6) the bending of light grazing the surface of the sun — the same as given by the general theory of relativity. 18 references. (auth)

1314

THE RELATIVISTIC CONFIGURATION SPACE FORMULATION OF THE MULTI-ELECTRON PROBLEM. Marian Günther. Phys. Rev. 88, 1411-21(1952) Dec. 15.

A relativistic-configuration space (many-time) presentation of quantum electrodynamics is developed, which, being equivalent to the Tomonaga-Schwinger formalism, may be expected to have the advantage of its direct applicability to bound-state problems of multi-electron systems. The main purpose of this paper is therefore to get an evidently relativistically invariant description of the interactions between individual electrons, in such a way, however, as to avoid those divergence difficulties which may be accounted for by the use of electron plane waves for building up the actual state of the system. The order of the presentation is as follows: a general relativistically invariant proof of equivalence of the Tomonaga-Schwinger formalism and the many-time formalism of Dirac, Fock, and Podolski provides a necessary starting point for further generalization, giving rise to a formal extension of the multi-electron wave-function concept into regions for which the latter remained hitherto undefined. A method of elimination of virtual processes is outlined and invariant expressions for the multi-electron interactions are derived. All explicit derivations in this paper are carried out to terms of the order of $e^2$. An example, a relativistic two-electron wave equation, is given. This equation accounts for the coulomb and Breit interactions. (auth)

# NEW NUCLEAR DATA

Summary of New Nuclear Data on Half Lives, Radiations, Relative Isotopic Abundances, Nuclear Moments, Neutron Cross Sections, Reaction Energies, and Masses.

Prepared by National Bureau of Standards Nuclear Data Group with the Assistance of Readers.

For a list of the abbreviations used in this section, see NSA, Vol. 7, No. 1, page "SUPPLEMENT 1".

**$_{42}Mo^{93}_{51}$** $6.7^h$

| | | | | |
|---|---|---|---|---|
| $\tau_1$ | | $6.95^h$ | Nb(p,n) | chem, rel $\sigma$ |
| $\gamma$ | $\sim 0.8\uparrow$ | 0.290 | | scin |
| | $\sim 1\ \uparrow$ | 0.690 | | |
| | $\sim 1\ \uparrow$ | 1.464 | | |

G.E.Boyd, R.A.Charpie, Phys. Rev. 88, 681(1952).

**$_{44}Ru^{99}_{55}$**

| | | | |
|---|---|---|---|
| I | | 5/2 | para |
| $\mu(Ru^{101})/\mu(Ru^{99})$ | | = 1.09 | |

J.M.E.Griffiths, J.Owen, Proc. Phys. Soc. 65A, 951(1952).

**$_{44}Ru^{101}_{57}$**

| | | | |
|---|---|---|---|
| I | | 5/2 | para |
| $\mu(Ru^{101})/\mu(Ru^{99})$ | | = 1.09 | |

J.M.E.Griffiths, J.Owen, Proc. Phys. Soc. 65A, 951(1952).

**$_{45}Rh^{104}_{59}$**

| | | | |
|---|---|---|---|
| Capture $\gamma$'s | Rh(n,$\gamma$) | | scin |
| | 0.080 | | |
| | 0.160 | | |

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**$_{46}Pd^{105}_{59}$**

| | | | |
|---|---|---|---|
| I | | 5/2 ? | s |
| $\mu$ | | -0.57 | |

A.Steudel, Z.Phys. 132, 429(1952).

**Ag**

Neutron resonances (ev) $E_n$ = 12 ev to 5 kev

| | |
|---|---|
| 5.15 ± 0.03 | 52 |
| 15.9 $\sigma_o\Gamma^2$ = 23 | 66 |
| 29.6 | 125 |
| 40 | |

A.W.Merrison, E.R.Wiblin, Proc. Roy. Soc. 215A, 278(1952).

**$_{47}Ag^{110}?_{63}$**

| | | | |
|---|---|---|---|
| Capture $\gamma$ | Ag(n,$\gamma$) | | scin |
| | 0.187 | | |

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**$_{48}Cd^{114}_{66}$**

| | | | |
|---|---|---|---|
| Capture $\gamma$'s | $Cd^{113}$(n,$\gamma$) | | s $\pi$ ce$^-$ |
| | 0.097 | | |
| | 0.562 | | |

C.T.Nibdon, C.O.Muehlhause, Phys. Rev. 88, 943 (1952); 87, 222A(1952).

| | | | |
|---|---|---|---|
| Capture $\gamma$'s | Cd(n,$\gamma$) | | scin |
| | 0.558 | | |
| | 8.5 | | |

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**$_{48}Cd^{117}_{69}$**

| | | | |
|---|---|---|---|
| $\tau$ | | $2.9^h$ | Cd(d,p) chem |
| $\gamma$ | | 1.2 | a |

A.H.W.Aten, Jr., W.Boelhouwer, Physica 18, 651 (1952).

**$_{49}In^{116}?_{67}$**

| | | | |
|---|---|---|---|
| Capture $\gamma$'s | In(n,$\gamma$) | | scin |
| | 0.160 | | |
| | 0.256 | | |

No crossover observed

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**$_{51}Sb^{124}_{73}$** $60^d$

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | (0.95) | $\Delta I = 2$, yes shape? | | sl |
| | 2.27 | $\Delta I = 2$, yes shape | | |
| $\gamma$ | (0.607) | $\frac{\alpha_K}{0.0038}$ | $\frac{K/L}{7.1}$ | E2 |
| | (1.7) | $\leq 5 \times 10^{-4}$ | | |

D.R.Hutchinson, W.L.Wiedenbeck, Phys. Rev. 88, 699(1952).

| | | | |
|---|---|---|---|
| $\gamma$ | 1.692 | | sl pe$^-$ |

D.E.Alburger, Phys. Rev. 88, 1257(1952).

| | | |
|---|---|---|
| No $\gamma\gamma(\theta)$, no $\gamma\gamma$ polarization-direction | | scin |
| $(2.27\beta^-)(0.60\gamma)(\theta)$, polarization-direction | | |
| I = 3, 2+, 0+ | | |

R.W.Kloepper, E.S.Lennox, W.L.Wiedenbeck, Phys. Rev. 88, 695(1952).

**$Te^{124}$ ?** (52 72)

Capture $\gamma$ — $Te(n,\gamma)$ — scin

0.609

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**$Te^{131}$** (52 79) $25^m$

| | | | | |
|---|---|---|---|---|
| $\tau$ | | $24.8^m$ | $Te(n,\gamma)$ | chem |
| $\beta^-$ | 45% | 1.35 | | a$\beta\gamma$ |
| | 55% | 2.0 | | a |
| $\gamma$ | 1.5↑ | 0.16 | | a |
| | 1.0↑ | 0.7 | | |

$\gamma\gamma$ $\beta\gamma$

K.Geiger, Z. Naturforsch. 7a, 579(1952).

**I**

Neutron resonances (ev) — $E_n$ = 5 ev to 5 kev

19.4 — $\sigma_o\Gamma^2$ = 23

29.6

43

A.W.Merrison, E.R.Wiblin, Proc. Roy. Soc. 215A, 278(1952).

**$I^{121}$** (53 68)

$\tau$ — 1.5$^h$ — d $40^m$Xe, p $17^d$Te

B.Dropesky, E.O.Wiig, Phys. Rev. 88, 683(1952).

**$I^{131}$** (53 78)

$\gamma$ — sl pe⁻, ce⁻

| | | $\alpha_K$* | K/LM | |
|---|---|---|---|---|
| 6↑ | (0.284) | 0.05 | 3.3 | E2 |
| 100↑ | (0.364) | 0.02 | 5.6 | E2 |
| 10↑ | (0.638) | $\alpha$ = 0.004 | | E2 |
| 3↑ | (0.723) | $\alpha$ = 0.003 | | E2 |

*Based on $\alpha_K$ = 0.097 for 0.662$\gamma$ of $Cs^{137}$

J.R.Haskins, J.D.Kurbatov, Phys. Rev. 88, 884 (1952).

**$Xe^{121}$** (54 67)

$\tau$ — $40^m$ — p 1.5$^h$I, I(240-Mev p) — chem

B.Dropesky, E.O.Wiig, Phys. Rev. 88, 683(1952).

**$Xe^{122}$** (54 68)

$\tau$ — $20^h$ — p 3.4$^m$I, I(240-Mev p) — chem

B.Dropesky, E.O.Wiig, Phys. Rev. 88, 683(1952).

**$Xe^{123}$** (54 69)

$\tau$ — 1.7$^h$ — p 13$^h$I, I(240-Mev p) — chem

B.Dropesky, E.O.Wiig, Phys. Rev. 88, 683(1952).

**$Cs^{128}$** (55 73)

$\tau$ — $3.8^m$ — d $24^d$Ba — chem

$\beta^+$ observed with 2.4$^d$Ba belongs to this daughter

W.Lindner, R.N.Osborne, Phys. Rev. 88, 1422(1952).

**$Cs^{134}$** (55 79) $2.3^y$

$\gamma\gamma(\theta)$, $\gamma\gamma$ polarization-direction — scin

I = 4+, 2+, 0+

R.M.Kloepper, E.S.Lennox, M.L.Wiedenbeck, Phys. Rev. 88, 695(1952).

**$Cs^{137}$** (55 82)

$\gamma$ — 0.6616 — cryst

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

**$Ba^{127}$** (56 71)

$\tau$ — $12^m$ — p 5.5$^h$Cs, Cs(190-Mev d)

W.Lindner, R.N.Osborne, Phys. Rev. 88, 1422(1952).

**$Ba^{128}$** (56 72)

$\epsilon$ ~100% — Cs(190-Mev d) — chem

$\beta^+$ in 3.8$^m$Cs daughter

W.Lindner, R.N.Osborne, Phys. Rev. 88, 1422(1952).

**$La^{140}$** (57 83)

Capture $\gamma$ — $La(n,\gamma)$ — scin

4.5

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**$Sm^{150}$** (62 88)

Capture $\gamma$'s — $Sm^{149}(n,\gamma)$ — s$\pi$ ce⁻

0.337 — K/L~4.4

0.440 — K/L~3

C.T.Hibdon, C.O.Muehlhause, Phys. Rev. 88, 943 (1952); 87, 222A(1952).

**$Sm^{151}$** (62 89)

| | | |
|---|---|---|
| $\beta^-$ | ~0.075 | Sm(th n); pc |
| $\gamma$ | 0.019 | pc |
| (0.019$\gamma$) ($\beta^-$) | | scin |

M.W.Wilson, G.W.Lewis, Proc. Phys. Soc. 65A, 656 (1952).

**$Eu^{155}$** (63 92)

| | | |
|---|---|---|
| $\beta^-$ | ~0.150 | Sm(th n,$\gamma\beta^-$); pc |
| | ~0.250 | |
| $\gamma$ | 0.015 | pc |
| (~0.150$\beta^-$) ($\gamma$) | ($\beta^-$) (0.015$\gamma$) | |

M.W.Wilson, G.W.Lewis, Proc. Phys. Soc. 65A, 656 (1952).

**$Gd^{153}$** (64 89)

$\gamma$ — 0.1037 — K/L = 5 — s$\pi$ ce⁻

No other $\gamma$ — Gd(pile n)

J.M.Cork, J.M.LeBlanc, W.M.Nester, F.B.Stumpf, Phys. Rev. 88, 685(1952).

**$Gd^{156}$, $Gd^{158}$** (64)

Capture $\gamma$'s — $Gd(n,\gamma)$ — s$\pi$ ce⁻

0.079 — K/L~0.3 — L/M~2.5

0.088

0.180

C.T.Hibdon, C.O.Muehlhause, Phys. Rev. 88, 943 (1952); 87, 222A(1952).

**$Tb^{161}$** (65 96)

| | | |
|---|---|---|
| $\tau$ | $6.8^d$ | Gd(pile n); s$\pi$ ce⁻ |
| $\gamma$ | 0.049 | L/M = 3.7 |
| No other $\gamma$ | | |

J.M.Cork, J.M.LeBlanc, W.M.Nester, F.B.Stumpf, Phys. Rev. 88, 685(1952).

**$Dy^{165}$** (66 99)

Capture $\gamma$'s — $Dy(n,\gamma)$ — s$\pi$ ce⁻

0.082

0.106

0.189

C.T.Hibdon, C.O.Muehlhause, Phys. Rev. 88, 943 (1952); 87, 222A(1952).

**$Er^{167}$** (68 99)

|Q| — 10.2 — para

G.S.Bogle, H.J.Duffus, H.E.D.Scovil, Proc. Phys. Soc. 65A, 760(1952).

**$Tm^{170}$** 69 101

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | 24% | 0.884 | Tm(pile n); sl $\beta\gamma$ | |
| | 76% | 0.968 | | sl |
| $\gamma$ | | 0.0841 | $\tau = 1.57 \times 10^{-9}$ s | |
| $\alpha_K = 1.6$ | $\alpha_L = 4.1$ | $\alpha_M = 1.2$ | | E2 |

$\epsilon_K < 0.3\%$ ($\beta$) (0.084$\gamma$)
No other $\gamma$'s (< 0.02%)
F-K plots of both $\beta$'s linear

R.L.Graham, J.L.Wolfson, R.E.Bell, Can. J. Phys. 30, 459(1952).

**$Ta^{182}$** 73 109

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 0.9† | 0.065714 | 1.9† | 0.17936 |
| | 10.0† | 0.067736 | 0.9† | 0.19830 |
| | 0.6† | 0.084667 | 4.5† | 0.22205 |
| | 4.6† | 0.10009 | 2.4† | 0.22927 |
| | 0.9† | 0.11366 | 2.7† | 0.26409 |
| | 0.2† | 0.11640 | 35.2† | 1.121 |
| | 4.3† | 0.15241 | 15.7† | 1.188 |
| | 1.4† | 0.15637 | 33.4† | 1.223 |

No Hf x ray — Ta(pile n), cryst
Possible decay schemes enumerated

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

**$W^{187}$** 74 113

| | | |
|---|---|---|
| $\gamma$ | 0.07200 | cryst |
| | 0.13425 | |
| | 0.4795 | |
| | 0.6189 | |
| | 0.6861 | |

0.6189$\gamma$ not crossover

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

**$Os^{185}$** 76 109

| | | |
|---|---|---|
| $\gamma$ | 0.654 | Os (pile n); sl $ce^-$ |
| | 0.88 | |

J.B.Swan, R.D.Hill, Phys. Rev. 88, 831(1952).

**$Os^{191}$** 76 115 — $14^h$

| | | | |
|---|---|---|---|
| $\tau_1$ | $14^h$ | Os(< 22-Mev $\gamma$) | Os(pile n) |
| No $\beta^-$ (< 5%) | | | s $\pi$ |
| $\gamma$ I.T. | 0.0742 | | s $\pi$ $ce^-$ (Os) |

$L_I : L_{II} : L_{III} : M_I : M_{II} : M_{III} : N$
42 : 24 : 100 : 14 : 35 : 15

J.B.Swan, R.D.Hill, Phys. Rev. 88, 831(1952).

**$Os^{191}$** 76 115 — 15.0$^d$

| | | | | |
|---|---|---|---|---|
| $\tau_2$ | $15^d$ | Os(< 22-Mev $\gamma$) | Os(pile n) | |
| $\beta^-$ | ~0.14 | | s $\pi$ | |
| $\gamma_1$ | 50%* | 0.0417 | | E2 |
| $\gamma_2$ | 100%* | 0.1291 | | M1,E2 |

K : $L_I$ : $L_{II}$ : $L_{III}$ : $M_I$ : $M_{II}$ : $M_{III}$ : N
$\gamma_1$ 32 : 40 : — : 11 : 19 : 9.5
$\gamma_2$ 100 : 30 : 11 : 6.0 : ← 12 → : 3.5

$[e^-_L(0.129\gamma)]\,[e^-_L(0.042\gamma)]$
*Assuming M1/E2 = 3 for 0.129$\gamma$

J.B.Swan, R.D.Hill, Phys. Rev. 88, 831(1952).

**$Os^{193}$** 76 117

| | | |
|---|---|---|
| $\tau$ | $32^h$ | Os(pile n), |
| $\beta^-$ | ~1 | not Os(< 22-Mev $\gamma$); a |

Weak $\gamma$'s with $14^h < \tau < 15^d$
~0.065 0.215 0.323 0.460

J.B.Swan, R.D.Hill, Phys. Rev. 88, 831(1952).

**$Ir^{192}$** 77 115

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 0.4† | 0.13633 | 30.0† | 0.46798 |
| | 1.0† | 0.20131 | 1.1† | 0.4848 |
| | 7.5† | 0.20574 | 1.1† | 0.5884 |
| | 38.0† | 0.29594 | 1.4† | 0.6045 |
| | 37.0† | 0.30845 | 0.5† | 0.6129 |
| | 99.0† | 0.31646 | | |

Os K x ray — Pt K x ray — Ir(pile n), cryst
Level scheme given

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

**Au** — Neutron resonance
4.85 ev

A.W.Merrison, E.R.Wiblin, Proc. Roy. Soc. 215A, 278(1952).

**$Au^{200}$** 79 121

| | | | |
|---|---|---|---|
| $\tau$ | 48$^m$ | $Hg^{201}$(< 28-Mev $\gamma$) | chem |
| $\beta^-$ | 2.2 | | a |
| $\gamma$ | 0.39 | | scin |
| | 1.13 | | |

$\beta/\gamma = 5$

F.D.S.Butement, R.Shillito, Proc. Phys. Soc. 65A, 945(1952).

**$Au^{201}$** 79 122

| | | | |
|---|---|---|---|
| $\tau$ | 26$^m$ | $Hg^{202}$(< 28-Mev $\gamma$) | chem |
| $\beta^-$ | 1.5 | | a |
| $\gamma$ | 0.55 | | scin |

$\beta/\gamma = 20$

F.D.S.Butement, R.Shillito, Proc. Phys. Soc. 65A, 945(1952).

**$Au^{202}$ ?** 79 123

| | | | |
|---|---|---|---|
| $\tau$ | ~25$^s$ | Hg(18-Mev n) | chem |

F.D.S.Butement, R.Shillito, Proc. Phys. Soc. 65A, 945(1952).

**$Au^{203}$** 79 124

| | | | |
|---|---|---|---|
| $\tau$ | 55$^s$ | $Hg^{204}$(< 28-Mev $\gamma$) | chem |
| $\beta^-$ | 1.9 | | a |
| $\gamma$ | 0.69 | | scin |

$\beta/\gamma = 10$

F.D.S.Butement, R.Shillito, Proc. Phys. Soc. 65A, 945(1952).

**$Hg^{200}$** 80 120

| | | | |
|---|---|---|---|
| Capture $\gamma$ | $Hg^{199}$(n,$\gamma$) | | s $\pi$ $ce^-$ |
| | ~0.28 | | |

C.T.Hibdon, C.O.Muehlhause, Phys. Rev. 88, 943 (1952); 87, 222A(1952).

**$Tl^{208}$** 81 127

| | | | | |
|---|---|---|---|---|
| $\gamma$ | | (2.62) | $\alpha_{pair} = 4.3 \times 10^{-4}$ | E2 s |

H.Slätis, K.Siegbahn, Arkiv Fysik 4, 485(1952).

| | | | |
|---|---|---|---|
| $\gamma$ | 0.05† | 0.27735 | $Th^{228}$ source, cryst |
| | 0.15† | 0.5108 | |
| | 0.40† | 0.5830 | |

0.24098$\gamma$ (0.10†) unassigned
† Relative to 0.238$\gamma$ of $Pb^{212}$

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

**Pb** — Variations in relative isotopic abundances

C.B.Collins, R.W.Farquhar, R.D.Russell, Phys. Rev. 88, 1275(1952).

**$Pb^{201}$ ?** 82 119 — $50^{s}$

| | | | | |
|---|---|---|---|---|
| $\tau_1$ | | $50^{s}$ | Tl(p) chem, not Hg(p) | |
| $\gamma$ | ~1† | 0.25 | | scin |
| | ~1† | 0.42 | | |
| | ~4† | 0.67 | | |

N.J.Hopkins, Phys. Rev. 88, 680(1952).

**$Pb^{202}$ ?** 82 120 — $5.6^{s}$

| | | | | |
|---|---|---|---|---|
| $\tau_1$ | | $5.6^{s}$ | Tl(p), not Hg(p) | |
| $\gamma$ | | 0.89 | | scin |

N.J.Hopkins, Phys. Rev. 88, 680(1952).

**$Pb^{207}$** 82 125 — $0.8^{s}$

| | | | |
|---|---|---|---|
| $\tau_1$ | | $0.8^{s}$ | |

N.J.Hopkins, Phys. Rev. 88, 680(1952).

**$Pb^{212}$** 82 130

| | | | | |
|---|---|---|---|---|
| $\gamma$ | | 0.23860 | | cryst |

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

**$Pb^{214}$** 82 132

| | | | | |
|---|---|---|---|---|
| $\gamma$ | | 0.053226 | $Rn^{222}$ source, cryst | |
| | 0.20† | 0.24192 | | |
| | 0.55† | 0.29522 | | |
| | 1.00† | 0.35199 | | |

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

**$Bi^{209}$** 83 126

| | | | |
|---|---|---|---|
| $\tau$ | $2 \times 10^{17}$ y | | ppl |
| $\alpha$ | 2.9 | | |

7 $\alpha$ tracks, $E_\alpha$ = 2.9, in Bi impregnated plate kept 100 days in $N_2$, 18°C

W.Riezler, W.Porschen, Z. Naturforsch. 7a, 634 (1952).

**$Bi^{212}$** 83 129

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 0.15† | 0.729 | $Th^{228}$ source, cryst | |

†Relative to 0.238$\gamma$ of $Pb^{212}$

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

**$Bi^{214}$** 83 131

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 1.6† | 0.6094 | $Rn^{222}$ source, cryst | |

†Relative to 0.352$\gamma$ of $Pb^{214}$

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

$\gamma\gamma(\theta)$ b ~0.3

F.Demichels, R.Malvano, Nuovo Cimento 9, 1106 (1952).

**$Ra^{227}$** 88 139

| | | | |
|---|---|---|---|
| $\tau$ | $41.2^{m}$ | | $Ra^{226}$ (n,$\gamma$) |
| $\beta^-$ | 1.30 | | |
| $\gamma$ | 0.29 | | |
| | 0.50 | | |

J.P.Butler, J.S.Adam, quoted by B.W.Sargent, Nature 170, 832(1952).

**$Th^{232}$** 90 142

| | | | |
|---|---|---|---|
| $\gamma$ | 0.075 | | ppl |
| $e^-/\alpha$ = 0.2 | | | |

G.Albouy, J. phys. radium 13, 309(1952).

**$Pa^{231}$** 91 140

| | | | |
|---|---|---|---|
| $\gamma$ | 0.044 | | cc |
| | 0.066 | | |

J.Tellilac, Ann. Phys. 7, 396(1952).

**$Pa^{234}$** 91 143 — $1.14^{m}$

| | | | |
|---|---|---|---|
| $\tau$ | $1.175^{m}$ | | |

F.Barendregt, Sj.Tom, Physica 17, 817(1951).

**$U^{233}$** 92 141

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 5† | 0.0428 | | pc |
| | 1† | 0.0561 | | |

(L x ray)/$\alpha$ = 0.04

†Photons per $10^4$ $\alpha$'s

D.West, J.K.Dawson, C.J.Mandleberg, Phil. Mag. 43, 875(1952).

| | | | |
|---|---|---|---|
| $\gamma_1$ | ~0.040 | | ppl |
| $\gamma_2$ | (0.056) | | |
| $\gamma_3$ | (0.099) | | |

$\alpha + e_1^-$, $\alpha + e_1^- + e_2^-$, $\alpha + e_3^-$ tracks

$(\alpha + e_1^-)/(\alpha + e_1^- + e_2^-)$ ~70 $(\alpha + e^-)/\alpha$ = 0.09

K.M.Bisgård, Proc. Phys. Soc. 65A, 677(1952).

**$U^{234}$** 92 142

| | | | |
|---|---|---|---|
| $\tau$ | $2.475 \times 10^5$ y | chem, ms; ic | |
| | ±0.016 | 95.99% $U^{234}$ | |

E.H.Fleming, Jr., A.Ghiorso, B.B.Cunningham, Phys. Rev. 88, 642(1952).

**$U^{235}$** 92 143

| | | | |
|---|---|---|---|
| $\tau$ | $7.13 \times 10^8$ y | chem, ms; ic | |
| | ±0.16 | 99.94% $U^{235}$ | |

E.H.Fleming, Jr., A.Ghiorso, B.B.Cunningham, Phys. Rev. 88, 642(1952).

**$U^{236}$** 92 144

| | | | |
|---|---|---|---|
| $\tau$ | $2.391 \times 10^7$ y | chem, ms; ic | |
| | ±0.018 | 96.65% $U^{236}$ | |

E.H.Fleming, Jr., A.Ghiorso, B.B.Cunningham, Phys. Rev. 88, 642(1952).

**$Pu^{238}$** 94 144

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 6† | 0.013 | | a |
| | 11† | 0.018 | | |
| | 0.4† | 0.042 | | |
| | | ~0.17 | | |

†Photons per $10^2$ $\alpha$'s

G.W.Reed, Jr., AECD-3185(1947); NSA 5-5421(1951).

| | | | |
|---|---|---|---|
| $\gamma$ | 0.0450 | | pc |

D.West, J.K.Dawson, C.J.Mandleberg, Phil. Mag. 43, 875(1952).

**$Pu^{239}$** 94 145

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 2† | 0.0385 | | pc |
| | 7† | 0.0520 | | |

(K x ray)/$\alpha$ = ~$2 \times 10^{-3}$ (L x ray)/$\alpha$ = 0.04

†Photons per $10^5$ $\alpha$'s

D.West, J.K.Dawson, C.J.Mandleberg, Phil. Mag. 43, 875(1952).

| | | | | |
|---|---|---|---|---|
| $\alpha$ | 11% | 5.100 | | a |
| | 20% | 5.137 | | |
| | 69% | 5.150 | | |

No other $\alpha$'s from 4.82 to 5.57 Mev (< 0.3%)

F.Asaro, I.Perlman, Phys. Rev. 88, 828(1952).

U L x ray/$\alpha$ = $3 \times 10^{-2}$ pc

H.Israel, Phys. Rev. 88, 682(1952).

| | | | | | |
|---|---|---|---|---|---|
| $Pu^{240}_{94\ 146}$ | α | 24% | 5.118 | Pu(pile n) | ms; s |
| | | 76% | 5.162 | | |

F.Asaro, I.Perlman, Phys. Rev. 88, 828(1952).

| | | | | |
|---|---|---|---|---|
| $Am^{241}_{95\ 146}$ | γ | 0.0603 | d $10^3$Pu; pc | |

D.West, J.K.Dawson, C.J.Mandleberg, Phil. Mag. 43, 875(1952).

## Neutron Cross Sections

| Reaction | σ Type | Value | Energy | Ref. |
|---|---|---|---|---|
| $Mo^{92}(n,2n)$ | $\sigma(15.5^m Mo)$ | graph | 13.2 - 27 | 52b2 |
| Ag(n) | $\sigma_t$ | graph | 12ev - 5kev | 52m4 |
| $Ag^{107}(n,2n)$ | $\sigma(24.6^s Ag)$ | 0.56 | 14.1 | 52f1 |
| $Ag^{109}(n,2n)$ | $\sigma(2.3^m Ag)$ | 1.0 | 14.1 | 52f1 |
| Cd(n) | $\sigma_t$ | 7900 | 0.18 ev | 52b3 |
| Cd(n,<11.5n) | $\sigma_{1n}$ | 1.89 | 14 | 52p2 |
| (n, <2.6n) | | 1.66 | | |
| (n, <1.4n) | | 1.14 | | |
| I(n) | $\sigma_t$ | graph | 5ev - 5kev | 52m4 |
| Au(n,<11.5n) | $\sigma_{1n}$ | 2.51 | 14 | 52p2 |
| (n, <2.6n) | | 2.06 | | |
| (n, <1.4) | | 1.47 | | |
| Pb(n,<11.5n) | $\sigma_{1n}$ | 2.56 | 14 | 52p2 |
| (n, <2.6n) | | 2.29 | | |
| (n, <1.4n) | | 0.91 | | |
| Bi(n,<11.5n) | $\sigma_{1n}$ | 2.56 | 14 | 52p2 |
| (n, <2.6n) | | 2.28 | | |
| (n, <1.4n) | | 1.03 | | |
| $Ra^{226}(n,\gamma)$ | $\sigma(42^m Ra^{227})$ | 22 | th ? | 52b4 |


52b2 R.Barloutaud, A.Lévêque, J. phys. radium 13, 412(1952).

52b3 B.N.Brockhouse, quoted by B.W.Sargent, Nature 170, 832 (1952).

52b4 J.P.Butler, J.S.Adam, quoted by B.W.Sargent, Nature 170, 832(1952).

52f1 S.G.Forbes, Phys. Rev. 88, 1309(1952).

52m4 A.W.Merrison, E.R.Wiblin, Proc. Roy. Soc. 215A, 278 (1952).

52p2 D.D.Phillips, R.W.Davis, E.R.Graves, Phys. Rev. 88, 600(1952).


## Packing Fraction Differences, Δf, in Units $10^{-4}$ amu

| Doublet | Δf | Ref. |
|---|---|---|
| $Pd^{102} - C_4H_3$ | -13.933 ± 0.008 | 52h3 |
| $Pd^{104} - C_4H_4$ | -15.32 ± 0.01 | 52h3 |
| $Pd^{105} - C_8H_9$ | -15.78 ± 0.01 | 52h3 |
| $Pd^{106} - C_4H_5$ | -16.57 ± 0.02 | 52h3 |
| $Pd^{106} - C_8H_{10}$ | -16.52 ± 0.02 | 52h3 |
| $Pd^{108} - C_4H_6$ | -17.64 ± 0.01 | 52h3 |
| $Pd^{110} - C_4H_7$ | -18.65 ± 0.01 | 52h3 |
| $Cd^{106} - C_4H_5$ | -16.26 ± 0.01 | 52h3 |
| $Cd^{108} - C_4H_6$ | -17.58 ± 0.01 | 52h3 |
| $Cd^{110} - C_4H_7$ | -18.74 ± 0.01 | 52h3 |
| $Cd^{111} - C_8H_{15}$ | -19.203 ± 0.007 | 52h3 |
| $Cd^{112} - C_4H_8$ | -19.818 ± 0.009 | 52h3 |
| $Cd^{112} - C_8H_{16}$ | -19.860 ± 0.008 | 52h3 |
| $Cd^{113} - C_8H_{17}$ | -20.231 ± 0.008 | 52h3 |
| $Cd^{114} - C_4H_9$ | -20.82 ± 0.01 | 52h3 |
| $Cd^{114} - C_3H_5O$ | -14.44 ± 0.01 | 52h3 |
| $Cd^{116} - C_3H_6O$ | -15.41 ± 0.01 | 52h3 |
| $In^{113} - C_8H_{17}$ | -20.245 ± 0.009 | 52h3 |
| $In^{115} - C_9H_7$ | -13.148 ± 0.009 | 52h3 |
| $Sn^{115} - C_9H_7$ | -13.17 ± 0.02 | 52h3 |
| $Sn^{116} - C_3H_6O$ | -15.65 ± 0.02 | 52h3 |
| $Sn^{116} - C_9H_8$ | -13.83 ± 0.01 | 52h3 |
| $Sn^{117} - C_9H_9$ | -14.299 ± 0.008 | 52h3 |
| $Sn^{118} - C_3H_7O$ | -16.72 ± 0.02 | 52h3 |
| $Sn^{118} - C_9H_{10}$ | -14.94 ± 0.02 | 52h3 |
| $Sn^{119} - C_9H_{11}$ | -15.376 ± 0.009 | 52h3 |
| $Sn^{120} - C_5$ | - 8.15 ± 0.01 | 52h3 |
| $Sn^{122} - C_5H$ | - 9.20 ± 0.01 | 52h3 |
| $Sn^{124} - C_5H_2$ | -10.169 ± 0.008 | 52h3 |
| $Te^{120} - C_9H_{12}$ | -15.79 ± 0.01 | 52h3 |
| $Te^{122} - C_5H$ | - 9.244 ± 0.007 | 52h3 |
| $Te^{122} - Ni^{61}$ | + 3.43 ± 0.05 | 52h4 |
| $Te^{123} - C_5H$ | + 9.06 ± 0.03 | 52h3 |
| $Te^{124} - C_5H_2$ | -10.340 ± 0.008 | 52h3 |
| $Te^{124} - Ni^{62}$ | + 3.71 ± 0.03 | 52h4 |
| $Te^{125} - C_5H_2$ | +10.16 ± 0.03 | 52h3 |
| $Te^{126} - C_5H_3$ | -11.359 ± 0.005 | 52h3 |
| $Te^{128} - C_{10}H_8$ | -12.273 ± 0.009 | 52h3 |
| $Te^{128} - Ni^{64}$ | + 3.81 ± 0.05 | 52h4 |
| $Te^{130} - Cu^{65}$ | + 3.95 ± 0.03 | 52h4 |
| $Te^{130} - C_5H_5$ | -13.180 ± 0.006 | 52h3 |
| $I^{127} - C_{10}H_7$ | -11.82 ± 0.01 | 52h3 |

Packing Fraction Differences, $\Delta f$, in Units $10^{-4}$ amu

| Doublet | $\Delta f$ | Ref. |
|---|---|---|
| $Xe^{124} - C_5H_2$ | $-10.098 \pm 0.005$ | 52h3 |
| $Xe^{126} - C_5H_3$ | $-11.31 \pm 0.01$ | 52h3 |
| $Xe^{128} - C_{10}H_8$ | $-12.432 \pm 0.006$ | 52h3 |
| $Xe^{129} - C_3H_7$ | $-20.12 \pm 0.01$ | 52h3 |
| $Xe^{130} - C_5H_5$ | $-13.451 \pm 0.006$ | 52h3 |
| $Xe^{131} - CO_2$ | $-4.94 \pm 0.03$ | 52h3 |
| $Xe^{132} - C_5H_6$ | $-14.394 \pm 0.009$ | 52h3 |
| $Xe^{132} - CO_2$ | $-4.95 \pm 0.01$ | 52h3 |
| $Xe^{134} - C_5H_7$ | $-15.257 \pm 0.007$ | 52h3 |
| $Xe^{136} - C_5H_8$ | $-16.051 \pm 0.006$ | 52h3 |

52h3 R.E.Halsted, Phys. Rev. 88, 666(1952).
52h4 B.G.Hogg, H.E.Duckworth, Can. J. Phys. 30, 628(1952).